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Following a literature search and contacts with equipment manufacturers and polymer converters, it was concluded that the goal of 3 year shelf life for a polymeric half steam table tray container is achievable using improved materials and that heat seal equipment can be designed with sufficient flexibility for both military and civilian product packaging. A Raque Heat Seal Machine, Model HS-100 (continuous motion) was acquired, installed at the CRAMTD Demonstration Site and satisfactorily sealed CPET Half-Steam Table Trays at 30 per minutes. Two potential suppliers of the polymeric tray pack were identified, Mullinix and Rexam. Also, two potential suppliers for the lidding stock, Roll Print and Heat Seal participated in the Project providing test materials. The polymeric tray pack design developed in the STP was recognized by the Eastern Dairy Deli Bakery Association as the "Best New Product - General" at its 1995 EDDA Show and Exhibition. Over 4,000 trays have been filled with a food product and heat sealed as part of CRAMTD operational demonstration. Retort tests of the CPET Mullinix tray with Heat Seal top lid film were successful.

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COMBAT RATION
ADVANCED MANUFACTURING
TECHNOLOGY DEMONSTRATION
(CRAMTD)

"Rigid Polymeric Container Processing"
Short Term Project (STP) #10

FINAL TECHNICAL REPORT
Results and Accomplishments (September 1991 through March 1995)
Report No. CRAMTD STP #10 - FTR15.0
CDRL Sequence A004
June 1996

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Contents

1.0 CRAMTD STP #10
Results and Accomplishments

1.1 Introduction and Background

STP#10, "Rigid Polymeric Container Processing", implementation was begun September 13, 1991 based on the proposal submitted May 30, 1991. The overall STP objective is to develop efficient production processes and the necessary equipment to fill, seal and thermostabilize operational rations in rigid (non-pouch) polymeric containers. To the maximum extent possible, the process, materials and equipment must accommodate both military and civilian products with minimum changeover, employing the principals of flexible manufacturing.

The Project was proposed by U.S. Army Natick Research, Development & Engineering Center (NRDEC) as typical and appropriate for joint development, with renewed emphasis on concurrent engineering to achieve mutual goals. NRDEC's initial interest in polymeric containers was as an alternative for the metal half steam table tray pack can. However, many sizes and configurations are found in civilian markets, and it is possible that several sizes will be used in future military feeding systems. Further, while DLA/DPSC emphasis is more on processing than on configuration or size, in this case the size and shape greatly effect the configuration of tooling to achieve proper sealing and handling without damaging the container. Therefore, there is a need to anticipate a variety of sizes, shapes, and even materials, all of which will have an influence on the processing parameters to be selected and developed.

1.2 Results and Conclusions

Following a literature search and contacts with equipment manufacturers and polymer converters, it was concluded that the goal of 3 year shelf life is achievable using improved materials and that heat seal equipment can be designed with sufficient flexibility for both military and civilian product packaging.

The Raque Heat Seal Machine, Model HS-100 (continuous motion) was acquired, installed at the CRAMTD Demonstration Site and satisfactorily sealed CPET Half-Steam Table Trays at 30 per minute.

Two potential suppliers of the polymeric tray pack were identified, Mullinix and Rexam. Also two potential suppliers for the lidding stock, Roll Print and Heat Seal participated in the Project providing test materials.

The polymeric tray pack design developed in the STP was recognized by the Eastern Dairy Deli Bakery Association as the "Best New Product - General" at its 1995 EDDA Show and Exhibition.

Over 4,000 trays have been filled with a food product and heat sealed as part of CRAMTD operational demonstration.

1.3 Recommendations

Continue tray sealing on the Raque Heat Seal Machine to develop operational experience. Explore alternate lid stocks and tray materials to define optimum tray/lid combination to withstand retorting and rough handling tests using the CPET tray and the recently available production Rexam PP/EVOH/PP tray.

In order to establish the technology for combat rations, however, additional steps are required including: final design to meet the military mission (including any secondary packaging, shipping, and delivery systems), production of field and qualification quantities of polymeric tray pack products (military specification or commercial item description), and any required inspection methods not presently included in combat ration producer protocols. A major partnership will be required with NRDEC in order to accomplish the objectives of such a project.

Seal area contamination has the same importance in tray pack heat sealing as recognized earlier with horizontal form/fill/seal pouches. Therefore, the seal area machine vision inspection technology being developed for MRE pouches should also be applied to polymeric tray packs.

Continued participation in the "Heat and Serve" Process Action Team being chaired by DPSC is also important to defining specific performance requirements.

2.0 Program Management

This STP was proposed as a three-phase work activity as illustrated on the attached figure Appendix 4.1, CRAMTD STP #10, "Rigid Polymeric Container Processing", Time & Events and Milestones. These cover the following:

Phase I Technology reviews, leading to a suitable material and tray design.

Phase II A Subcontractor will fabricate, test and assemble manufacturing equipment.

Phase III Testing, modifying and demonstration runs will be made as required.

Work on STP #10 was suspended at the end of August 1992 and on September 23, 1992 a significant portion of the funding was deobligated. This action was taken in order to fund critical

work on two Short Term Projects. Shortly thereafter, the decision was also made to withhold award of the pending full-scale polymeric tray sealing machine subcontract until full funding was once again available. On March 11, 1993 the delivery date was extended to December 14, 1993 and subsequently funds were reobligated on June 11, 1993. A further extension to September 30, 1994 was requested/necessitated by increased technical effort devoted to: 1) polymeric tray container design, 2) engineering rework of the manufacturing line, and 3) delays in equipment subcontracting. A final extension was granted to March 29, 1995.

2.1 Summary of STP Accomplishments

- The results of a literature survey indicated that shelf life goals are achievable with developing new materials such as OXBAR.
- In cooperation with the U.S. Army Natick Research, Development and Engineering Center, visited Springborn Laboratories to become appraised of their past efforts and sucesses.
- Preliminary engineering followed from contacts with two heat seal machine manufacturers (Raque and FEMC) and demonstration at FEMC.
- Specifications developed for a Polymeric Tray Seal Machine.
- Following Pre-bid conference, receipt of bids and evaluation, Raque Food Systems was selected as the recommended Subcontractor for the Polymeric Tray Sealing Machine.
- Redesigned Flange area on an existing polymeric tray mold to improve machine sealing.
- Mullinix subcontracted to supply CPET Trays to Raque to test on their machine and also for demonstration testing.
- The Raque Heat Seal Machine was installed and demonstrated for the March 8, 1995 Annual Contract Briefing.
- Preliminary retort tests were made on the CPET Mullinix tray with a Heat Seal Co. film and containers and seals survived.
- Identified 2 potential suppliers of polymeric tray pack containers (Mullinix and Rexam) and 2 potential suppliers of lidding stock (Rollprint and Heat Seal).
- Commercial customer established for civilian version of polymeric tray pack based product and over 2,000 units delivered to date.

3.0 Short Term Project Activities

3.1 STP Phase I Task

3.1.1 Review Current Technology (Task 3.2.1.1)

Potential barrier materials were identified from a review of literature and through contacts with manufacturers and converters in order to become familiar with the processing. (Appendix 4.2)

EVOH Laminates

EVOH laminated with polypropylene provides an oxygen and moisture barrier. Since the oxygen barrier quality of EVOH decreases with increasing moisture content, thicker layers are required. The material can be thermoformed.

Desiccant Surrounding EVOH

A desiccant can be added to the adhesive layers surrounding the EVOH which acts to delay penetration of moisture to the EVOH. The manufacturer claims that the thickness of the EVOH can be halved. The material can be thermoformed.

Mica Filled EVOH

EVOH blended with mica crystals enhances the barrier properties of EVOH up to three times. The material can be injection molded.

SiO2

Silicon dioxide is a post forming surface treatment with very good barrier properties. The coating is brittle and susceptible to cracking.

"Oxbar" Blended with Polymers

This new development is not yet commercially available. The "OXBAR system consists of a matrix polymer (for example, PET), an oxygen scavenging/absorbing component and a catalyst. The barrier material chemically binds oxygen. Up to 3 year shelf life is claimed.

The goal of 3 year shelf life appears to be achievable using improved EVOH/desiccant, EVOH/Mica or Oxbar barrier technologies.

3.1.2 Transfer/Study Natick Data (Task 3.2.1.2)

A meeting with Natick was held on February 20-21, 1992 to build on Natick experience and progress and avoid duplication of effort. The tray material PP/EVOH/PP was produced by American National Can and was thermoformed by Springborn Laboratories. While satisfactory

for prototype testing, a new sealing flange design was needed that was beyond the capabilities of Springborn thermoforming equipment (Appendix 4.3).

3.1.3 Preliminary Engineering (3.2.1.3)

Detailed engineering discussions were held with three equipment vendors: FEMC, Raque and Holmatic. Based on these discussions, specifications (Appendix 4.4) were completed for a Polymeric Tray Sealing Machine in preparation for a pre-bid conference. The specifications include the requirement to be able to heat seal not only the large half steam table tray (at 30/min) but with change parts two intermediate sizes, such as 10 oz. and 40 oz. Trays at higher production rates.

3.1.4 Design/Development Drawings (3.2.1.4)

The original plant layout drawings developed retained the use of the Yaguchi Seamer showing conveyors going to the Heat Seal Machine. This provided the flexibility to run metal or plastic half steam table trays. (Appendix 4.5) Due to budget constraints this approach was modified. The Yaguchi Seamer was removed from the end of the Tray Line and the Raque Heat Sealer installed in-line with the filling conveyor. (Appendix 4.6).

3.1.5 Technical Review (3.2.1.5)

At the Program Manager/COTR Meeting on June 10, 1992, the Phase I results were reviewed and the revised layout in Appendix 4.6 was approved. The recommendation was to proceed to Phase II.

3.2 STP Phase II Task

3.2.1 Subcontract Award (Task 3.2.2.1)

A Pre-Bid Conference was held on August 5, 1992 for the design, manufacture and installation of a heat seal machine to seal a polymeric tray. Three vendors attended: FEMC, Fords Holmatic and Raque Food Systems. Fords Holmatic declined to submit a proposal. Bids were opened August 13, 1992, the vendor evaluation (Appendix 4.7) was made and Raque's proposal was selected.

Work on STP #10 was suspended at the end of August 1992 and on September 23, 1992 a significant portion of the funding was deobligated. This action was taken in order to fund critical work on two new STPs.

Although funding was reobligated June 11, 1993, the subcontract to Raque was not awarded until August 1993. The award was then based on a revised proposal (Appendix 4.8) which could be accommodated within the budget available.

3.2.2 Fabrication/Assembly/Monitoring (3.2.2.2)

3.2.2.1 Heat Seal Machine

A trip to Raque was made on November 5, 1993 to review the engineering details and the integration with the Tray Pack Line.

During our review of Raque's engineering of the infeed conveyor to the Heat Seal Machine, it was a concern that gravy may spill on the flange area when the tray is transferred from the Tray Pack Line filling conveyor to the Heat Seal Machine. Therefore, we requested that Raque lengthen their infeed conveyor to provide space for our Oden Filler to fill gravy on the Heat Seal Machine when the trays are in the tray carriers.

3.2.2.2 Polymeric Container

Rexam Containers, with whom we had been working for over one year with trays produced on a one-up prototype mold, informed us that due to losing their potential commercial container customer they could not justify the investment needed to fabricate production tooling (estimated cost of $140,000) and therefore did not want to continue suppling us with trays from the prototype tooling.

We then contacted Mullinix who already had tooling for a CPET half steam table tray. Mullinix's standard tray was reviewed with Raque and volume comparisons were made of the present metal tray can, the prototype Natick tray and a sample CPET tray provided by Mullinix. (Appendix 4.3) For the same outside dimensions, the plastic tray has to be approximately 0.25 inch deeper. This is due to the greater flange area of the plastic tray reducing the interior volume. (Appendix 4.9) It was decided that the seal area had to be at least 0.25 inch to properly have the tray fit into the machine tray carriers. The polymeric tray drawing (Appendix 4.9) was approved for fabrication by CAFT/CRAMTD and Raque. Mullinix modified their tooling to fabricate trays according to this approved drawing. This tooling change delayed Raque's delivery of the heat seal machine.

3.2.3 Testing/Debugging (3.2.2.3)

During Raque's testing and debugging, minor modifications had to be made to the Die Cut Knife Assembly to achieve clean cutting of the lid material.

3.2.4 Install At Site (3.2.2.4)

Before Raque shipped the heat sealer to CRAMTD, a final visit was made on March 3, 1995 to give tentative approval. The machine was delivered to FMT on March 6 and electrical, air and vacuum utilities were completed the next day. The Heat Sealer was in operation the afternoon of March 7 and demonstrated in time for the ACB March 8 meeting.

3.3 STP Phase III

3.3.1 Testing/Modifying Runs (3.2.3.1)

The acceptance tests did not include running the filling conveyors, checkweigher and reject diverter. They were electrically disconnected when the Raque Heat Sealer replaced the Yaguchi Seamer. These items were reconnected and electrically integrated to the Raque Heat Sealer. Tests were made and Raque returned to change the vacuum chamber air cylinders for quieter operation.

3.3.2 <u>Initial Demonstration Runs (3.2.3.2)</u>

3.3.2.1 Heat Seal Machine

The Heat Seal Machine was demonstrated at the March 8, 1995 Annual Contract Briefing Meeting. The machine was demonstrated for 30 minutes with trays manually filled with peas and carrots at production rates varying from 20 to 30 per minute.

3.3.2.2 Polymeric Container

Retort tests were made with the CPET Mullinix half steam table tray with a Heat Seal Packaging top lid film (Appendix 4.11) consisting of 1.3 mil foil/48 gauge polyester heat seal coating. The top lid film seal was satisfactory. No change in the tray was observed.

Ultimately Rexam did acquire a customer with the result that two major potential suppliers of the polymeric tray pack were identified that had tooling available for a shelf stable half steam table tray:

Mullinix Packages, Inc. 3511 Engle Road Fort Wayne, Indiana 46809	Rexam Containers 710 West Park Road Union, Missouri 63084

Mullinix were the first to introduce CPET trays to the food industry in 1984 and first to produce shelf stable CPET packaging. Rexam were the first to produce a multilayer (PP/EVOH/PP) polymeric food tray in 1986.

3.3.2.3 Lidding Stock

Test runs were made with lid sealing temperatures ranging from 365 - 430°F and sealing times from 1 to 4 seconds. The optimum sealing results (Appendix 4.10) were at a sealing temperature of 405°F and a sealing time of 4 seconds.

Tensile and burst seal strength tests were made with Roll Print (polyester/aluminum foil/heat seal layers) and Heat Seal top films. The seal strength increased as the temperature and seal time increased. Burst tests also improved as the temperature and seal time was increased. (Appendix 4.10).

Two potential suppliers for the lidding stock, Rollprint and Heat Seal have been participating in the Project providing test materials. They are:

Rollprint Packaging Products, Inc. 320 Stewart Avenue Addison, Illinois 60101	Heat Seal Packaging Inc. 21919 Dumberry Vaudreuil, Quebec J7V8P7

Lid Stock data sheets from Roll Print and Heat Seal are attached (Appendix 4.11).

3.3.3 <u>Technology Transfer</u>

Attended two PAT (Process Action Team - Heat & Serve Meetings held by DPSC on January

23 - 24 and March 12 - 13, 1996 to review alternative methods and materials for group feeding. Presented cost data for Raque change parts, Mullinix CPET trays and lid stock. The Raque Heat Seal Machine operation and capabilities were reviewed and compared to the Yaguchi Seamer. One main difference is that the Raque Sealer is not dedicated to seal only one size tray as is the Yaguchi. With change parts, Raque can heat seal various sizes of trays. (Appendix 4.12) Trays sealed on the Raque Heat Seal Machine were passed around for review.

3.4 Operational Demonstration

On October 20, 1995, the Eastern Dairy Deli Bakery Association recognized the Polymer Tray-Pack Container as the "Best New Product - General". The container, which was shown at the EDDA Taste Show & Exhibition, was designed to meet the needs of the DoD for combat ration unit feeding and also serve in the civilian marketplace.

On November 7, 1995, December 14, 1995 and December 19, 1995, test runs of approximately 60 trays each were produced of a 6 lb tray filled with a macaroni and cheese product. These preproduction runs were for a large New Jersey supermarket chain. Production was initiated on February 28, 1996 and through April 15, 1996, approximately 2,000 units have been supplied. These products are distributed refrigerated.

Specific attention to seal area contamination in the last two production lots (April 8, 1996 and April 15, 1996) identified 5 defects/247 trays in the April 8th lot and 2 defects/255 trays in the April 15th lot. A seal area inspector is now used downstream of the filler (prior to the trays entering the Heat Sealer). Attention to seal area contamination will continue.

A 40-mil CPET Mullinix tray is being used for the commercial market versus the 60-mil tray proposed for military use. In addition, Rexam has provided Polypropylene/EVOH trays for testing and initial sealing on the Raque Heat Sealer resulted in a strong non-pealable lid. Work will continue with additional lid stocks and tray designs. For example, alternate lip designs on the tray require different tray carriers for the Raque Heat Sealer but increase the availability (without mold investment) of polymeric trays.

4.0 Appendix

4.1 Figure 1 CRAMTD STP #10 Time and Events Milestones

4.2 Literature Review of Polymeric Barrier Materials

4.3 Trip Reports to Springborn and NRDEC

4.4 Specification for Polymeric Tray Sealing Machine

4.5 Plant Floor Layout, Can Seamer and Tray Sealer

4.6 Plant Floor Layout, Modified - Tray Sealer Only

4.7 Proposal Evaluation Heat Sealer Scoring

4.8 Revised Raque Food Systems Heat Sealer Proposal

4.9 Mullinix Tray Design

4.10 Sealed Polymeric Tray/Lid Burst test Results

4.11 Lid Stock Data Sheets

4.12 Process Action Team Handout, March 12-13, 1996

Figure 1 - CRAMTD Short Term Project #10
Rigid Polymeric Container Processing
Projected Time & Events and Milestones

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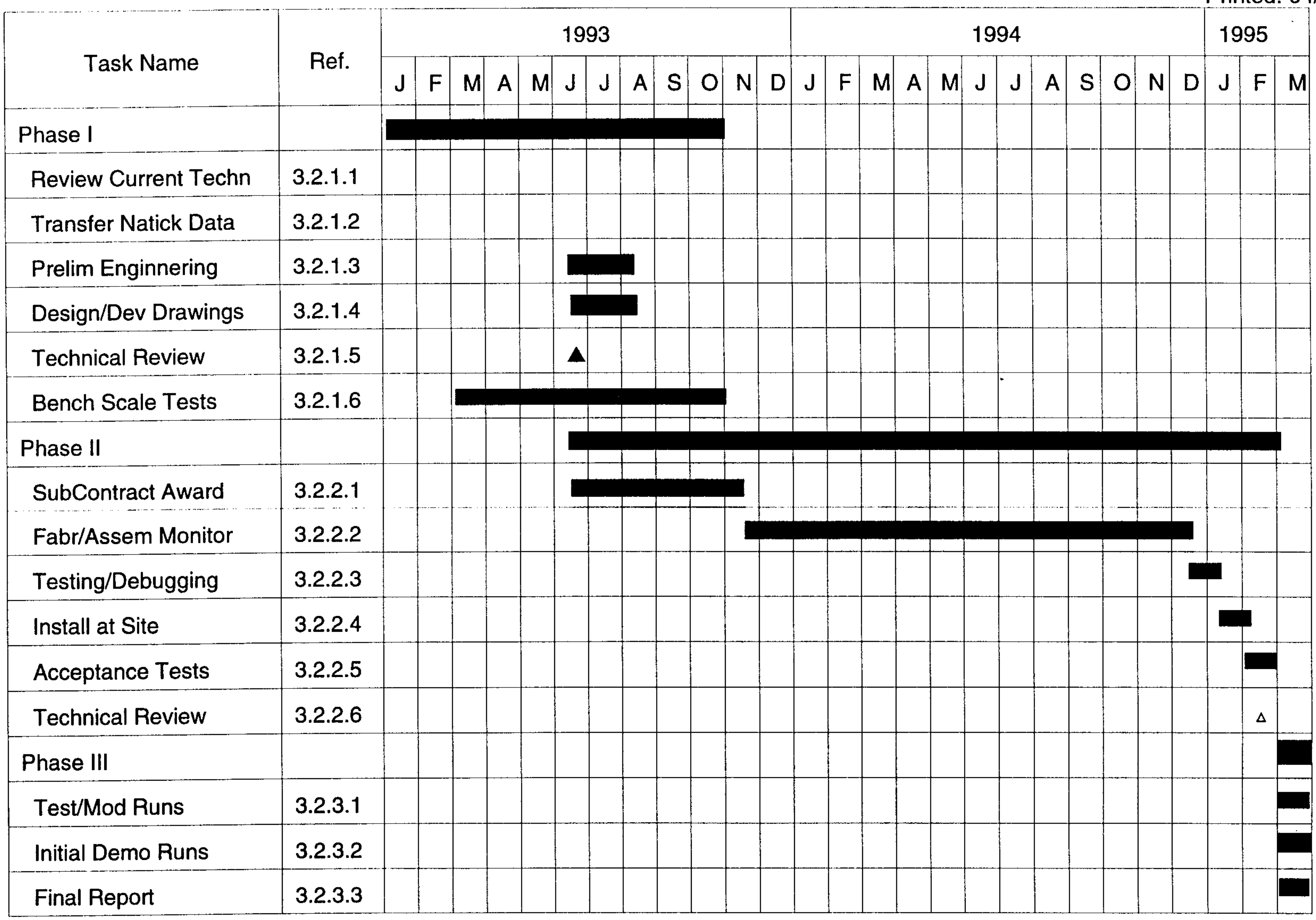

STP-10

Literature Review of Polymeric Barrier Materials

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I. Executive Summary

A. This report summarizes our study on the currently available polymeric materials for shelf stable rigid trays. The findings and recommendations were based on literature search, industry surveys, consultation with experts, and our analysis.

B. The polymeric prototype steam table trays supplied to Natick do not meet the three year shelf life requirement. Our calculations indicate that the bottom stock (a 7-layer PP/EVOH laminate) as well as the lid stock (a 4-layers PET/PVDC laminate) do not provide the necessary oxygen barrier. Fortunately, it is possible to develop new and adequate bottom and lid stocks. The development effort should be based not on arbitrarily increasing the thicknesses of the barrier layers (i.e., the EVOH layer in the bottom stock and the PVDC layer in the lid stock), but on sound design of the laminate structures with careful considerations of factors such as the deterioration mode of the food, and the recyclability, formability, peelability, retortability, and mechanical strength of the laminate. In additional to EVOH and PVDC, new oxygen barrier materials are also becoming available, and it behooves us to evaluate our options. Among the available oxygen barriers, the most promising candidates are EVOH, mica-filled EVOH, or SiO_x coated materials. The pros and cons of these materials, along with the less promising materials, are discussed in this report.

C. We recommend entering this STP into Phase II. At the same time, we recommend a program consisting of the following three tasks to develop new bottom and lid stocks adequate for three year shelf life. These tasks have an estimated total duration of six months; if implemented simultaneously with the tasks for Phase II, these tasks should not delay the progress of the project. Since these tasks are not included in the original

proposal of this STP, additional resources will be required. These three tasks are described as follow.

1. Obtain shelf life data of the foods to be contained in the trays. These data are critical for defining the barrier requirement of the bottom and the lid stocks. Since the term "shelf life" is often very loosely defined, "guesstimations" without actual shelf life data can lead to poor designs. We recommend obtaining the shelf life data of two typical foods (for example, beef stew, and pea and carrot) for designing the structures of the laminates. If Natick already have these data, we can use them immediately for our shelf life predictions; otherwise, these data may be obtained using the experimental procedures described in this report. The estimated duration of this task is three months.

2. Initiate a joint effort between Rutgers and American National Can to develop a new EVOH bottom stock and a new PVDC lid stock that can provide the trays with three year shelf life. The structures of these stock materials will depend on the shelf life data, retortability, sealability, peelability, recyclability, etc. The bottom stock will be thermoformed into trays at Rutgers, Springborn, or American National Can. The preform trays will be heat sealed either using the Raycon at Natick or using the new heat sealer in tray pack line at Rutgers. The mechanical and barrier performance of the trays will be evaluated experimentally.

3. Further investigate the viability of mica-filled EVOH and SiO_x coated trays as alternatives for the plain EVOH laminates. Although are not available in the United States, these trays are being made overseas. The immediate task is to make arrangement with interested parties to provide us with prototype trays for evaluation. This will allow us to compare the cost and performance of these materials with the plain EVOH, for determining which is the most suitable material.

II. Objectives

A. The objective of this study is to define the current technology of polymeric barrier materials through literature review, industry survey, and consultation with experts. Some of the questions this study attempts to answer are:

1. Can the prototype trays which were supplied to Natick meet the three year shelf life requirement?

2. What options do we have for barrier materials? In terms of availability, performance and cost, what is the potential of each of these materials?

B. The result of this study is used to define the feasibility and to develop an approach of producing stock materials that can be used to product trays with three year shelf life.

III. Critical Considerations

A. Before discussing the polymeric barrier materials used in the tray, we need to examine its relationship with shelf life. The shelf life of a food package depends on the package, the storage environment, and the nature of the food (Yam et al., 1992). If these three factors are understood quantitatively, we may develop a simple mathematical model to estimate the shelf life of the food trays.

B. The key package variables are the surface area, thickness, and permeability. The surface area is determined by the size of the trays, the permeability is determined by the material used, and the thickness is determined by the barrier and mechanical requirement. The key environmental variables are relative humidity and temperature. Although some of these variables (namely, relative humidity and temperature) may change with time, some reasonable average values may be used for shelf life estimation

C. The difficulty in shelf life estimation is the lack of shelf life data, or the knowledge of the deterioration rate of the food as a function of environmental conditions. The term "shelf

life" is often very vaguely defined, mostly based on trial-and-error or gut feeling. Obviously, there is a need for a more scientific approach.

D. For packaging moist foods such as beef stew, a major deterioration mode is the lipid oxidation of fat, through an autocatalytic free radical mechanism that leads to undesireable off-flavors. The consumer can detect rancidity even if only a very small amount of fat is oxidized. Therefore a good barrier is needed to inhibit the amount of oxygen entering the food package. For shelf life estimation, it is convenient to define "a maximum allowable oxygen" above which the quality of the food becomes unacceptable. Using the maximum allowable oxygen and permeation theory, we can calculate the package requirements and design the structure of the laminate. Although there are ranges of maximum allowable oxygen values for some foods published in the literature, the validity of these data are questionable because they are seldom backed up with scientific data.

E. Instead of relying of gut feeling, we need to obtain reliable shelf life data. If Natick already has these data, we can use them immediately. Otherwise, we can measure these data using accelerated experiments. For example, we can prepare two typical foods, put them into several actual size trays, evacuate the residual gas, and heat seal the trays with lids. After retorting, we can inject various known amount of oxygen into the trays. The quality of the foods can be monitored over time by sensory evaluation and/or objective measurement such as the TBA values. From these result we can estimate the shelf life data for these foods.

IV. Prototype Trays Supplied by Natick

A. Natick provided us with some prototype steam table polymeric trays for evaluation. The bottom stock was a 50 mil 7-layer polypropylene/EVOH laminate produced by American National Can, and it was thermoformed into trays by Springborn. According to Roger

Genske who designed this laminate, the structure of this laminate is PP-PE blend/regrind/tie/EVOH/tie/regrind/PP-PE blend. The middle is a EVOH (32% ethylene content) layer of 2 mil thick before thermoforming. A desiccant is incorporated in the tie layer to retard moisture transfer to the EVOH layer.

B. Figure 1 shows the calculated amount of oxygen that will permeate through the tray in three year as a function of the EVOH thickness at two temperatures. The calculations are based on the assumptions that the EVOH is dry (i.e. 0% RH) and contains 32% ethylene content. As expected, the amount of oxygen permeated decreases with increasing EVOH thickness and decreasing temperature. After thermoforming the EVOH layer will become thinner, say, 1.5 mil. For a 1.5 mil thick EVOH, Figure 1 indicates approximately 15 cc oxygen will permeate the tray. However, there is another complication that will likely cause more oxygen to permeate through the tray—since EVOH is moisture sensitive, its barrier properties decrease greatly with increasing relative humidity (Figure 2). Moisture can plasticize the EVOH, cause irreversible structure change, lead to increased free volume and permeability. As a result, if the EVOH layer is wet, it is possible that the actual amount of oxygen permeated through be many times higher than 15 cc. Increases in relative humidity of the EVOH layers may be caused by retorting or the laminate being exposed to the wet surface of the food.

C. Incorporating a desiccant in tie layer has shown to be able to partly alleviate the problem of moisture effect on the EVOH layer. However, American National Can informs us that containers with desiccant tie layer may form blisters on the outer surface if the containers are microwaved.

D. The lid stock is a PET/PVDC/PET/Coex laminate. The barrier layer is a 2 mil thick PVDC. In general, the oxygen permeability of PVDC is at least a few times higher than that of EVOH. The permeability of the lid stock given to us by Springborn (see attachment) are suspiciously low. In our opinion, the oxygen transmission rate through

the lid is at least as high as that of the tray. However, we will confirm this with American National Can.

E. From the above discussion, we estimate that at least 30 cc of oxygen will permeate through the tray in three years. It is very likely that this amount of oxygen is so high that it will cause unacceptable level of lipid oxidation for most foods, and therefore we conclude that the prototype trays do not meet the three year shelf life requirement.

F. We should mention that the solution is not simply increasing the thickness of the barrier layer. For example, the EVOH has a practical limit of 10% of the total thickness of the laminate, and if too much EVOH is used, the scrap cannot be recycled in the regrind layer. Many other factors such as heat sealability, thermoformability, peelability, and mechanical properties are also needed to be considered.

V. High Barrier Polymeric Materials

A. Below is a discussion of the oxygen barrier materials.

B. EVOH Barrier Laminates

1. Manufacturers/Converters

   a) Du Pont's EVOH resin, e.g., Selar® OH BX 230 (a 32% ethylene content suitable for deep drawing).

   b) EVAL® resins, e.g., EP-F (a 32% ethylene content base)

   c) American National Can Co.

2. Pros

   a) Good oxygen barrier, especially when it is dry (see Figure 2).

   b) Thermoformable, retortable, and readily available.

3. Cons

a) It is moisture sensitve and loses much of its barrier ability at high relative humidity. Incorporating a desiccant in the tie layer may alleviate part of this problem.

b) Usable life of the desiccant is limited.

c) Desiccant tie layer is not recommended as a stock material for microwaveable packages.

d) If its thickness exceeds 10% of the total laminate, the scrap cannot be used as regrind.

4. Comments

a) This material is very promising because it is readily available.

C. Mica-filled EVOH Laminates

1. Manufacturer

a) Du Pont's EVOH resin, Selar® OH Plus 3002P3 (32% ethylene content of the base resin blended with thin, flat, mica wafers).

2. Pros

a) Up to three times the barrier properties of the unfilled EVOH.

b) Increased rigidity compared to unfilled EVOH.

3. Cons

a) Cannot be thermoformed (can be used in melt phase forming operations, e.g., injection molded)

b) No company in the United States is using this material yet. (However, a company in Australia is using it to make trays.)

4. Comment

a) This material has some potential and should be investigated further.

D. SiO_x Coated trays

1. Manufacturers

a) Toppan Printing, Tokyo, Japan

b) Eastapac

2. Pros

a) Good oxygen barrier.

b) Professor Jack Giacin from Michigan State University told us that he had a student from Toppan Printing who recently did some research with this materials, and the barrier and mechanical properties look quite promising.

3. Cons

a) It is mostly used as a coating.

b) Very thin coatings (800 A) are prone to pinholes and cracks.

4. Comments

a) Eastapac told us that CPET trays coated with SiO_x have 5-100 times the oxygen barrier of uncoated trays, depending on the thickness of the coating. The coating can be applied on the inside, outside, or both inside and outside of the tray. The cost of coating is 3-4¢ per tray.

b) There seem to be recent advances in this materials. We should investigate this material more.

E. OXBAR Blend Barrier Films

1. Manufacturer

a) CMB Packaging Technology, England

2. Pros

a) OXBAR is based on commodity polymers (PET 95–99%, MXD6 Nylon 1–5%, and cobalt salt 50–200 ppm) and it can chemically bind the permeating oxygen. Permeation should be an order of magnitude better than that of EVOH polymers.

3. Cons

a) Usable life of OXBAR is around 15 months.

b) It is still in the development stage.

c) Presently the company is working on meeting the FDA regulations and is holding back on commerical contacts.

4. Comment

a) It will take a long time before this material becomes available commercially.

VI. **Personal Contacts**

A. Springborn Laboratory, Inc., Enfield, Connecticut.

1. James P. Galica, director, Materials Engineering & Information Services. (203) 749-8371

B. CMB Packaging Technology, England

1. Jim Nicholas, Oxbar development. Tel 0235 772929

C. Toppan Printing, Japan

D. Du Pont

1. I-Hwa Lee, Technical Specialist

E. Dow Chemicals

1. Philips Delassius, (517) 636-1000

F. America National Can

1. Roger Genske

2. Mark Weber, Manager, Specification & Regulatory Affairs,

3. Gale Russel

G. Eastapac

1. Dave Niehous, 4021 Pike Lane, PO Box 6267, Concord, CA 94527. (501) 671-0140

H. Professor Jack Giacin, School of Packaging, Michigan State University.

I. Professor Charm Mannheim, Food Science Department, Technion—Israel Institue of Technology.

J. Professor Joseph Miltz, Head of Technion Packaging Laboratory, Technion—Israel Institue of Technology.

K. Professor Sy Gilbert, Associate Director of Center of Packaging Engineering, Rutgers University.

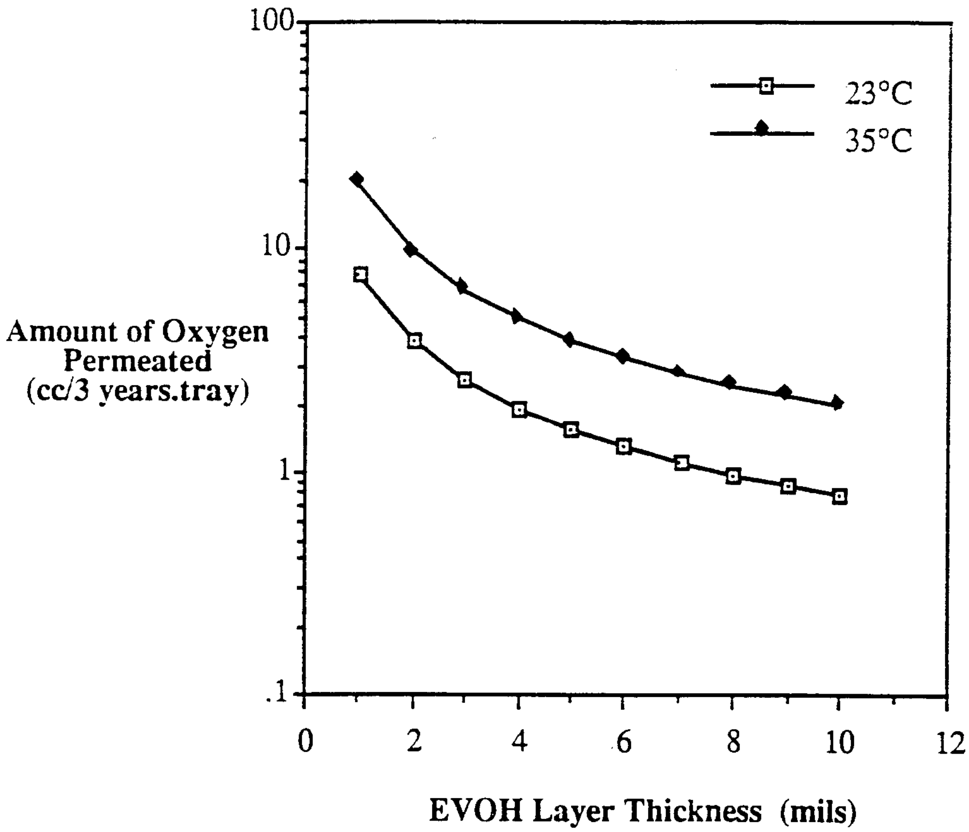


Figure 1. Amount of oxygen permeating the tray in three years (the EVOHhas 0% RH and 32% ethylene content)

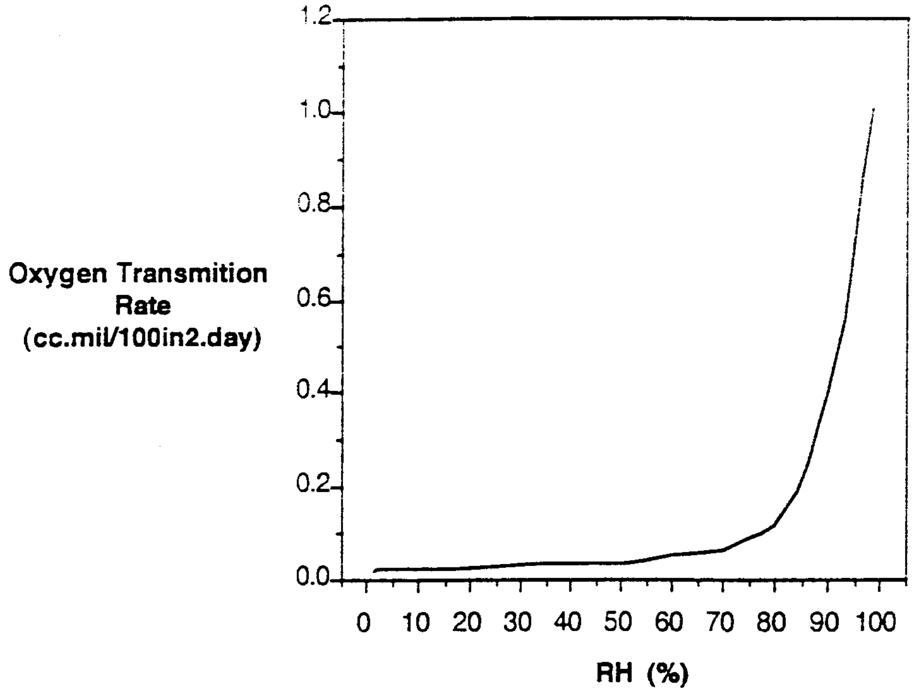
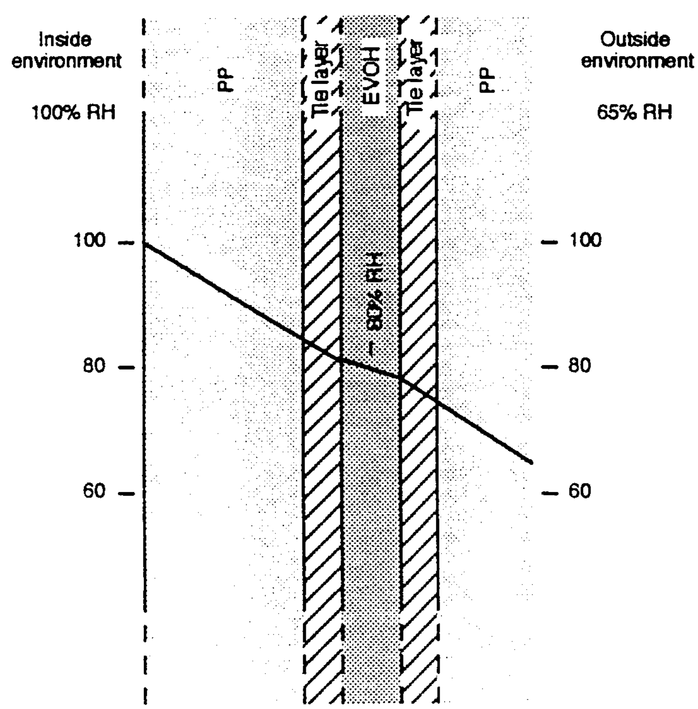


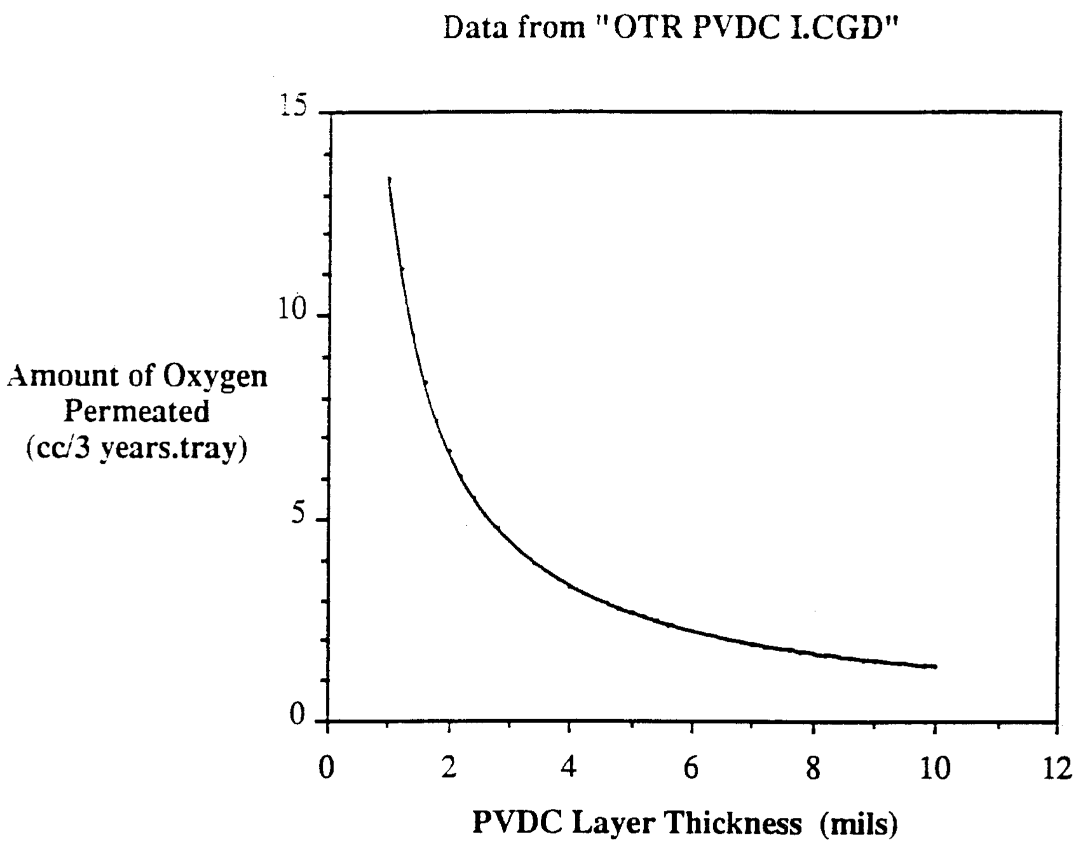
Figure 1. Oxygen transmission rate of the EVOH layer at 25°C (32% ethylene content).



40% reduction ?
of the original

~~C.K~~

Figure 2. Example of the exposure of the EVOH layer on humidity, due to moisture transfer from inside the tray outside.



Data from "OTR PVDC I.CGD"
15
10
5
0
Amount of Oxygen
Permeated
(cc/3 years.tray)
0
2
4
6
8
10
12
PVDC Layer Thickness (mils)

VII. Literature Review

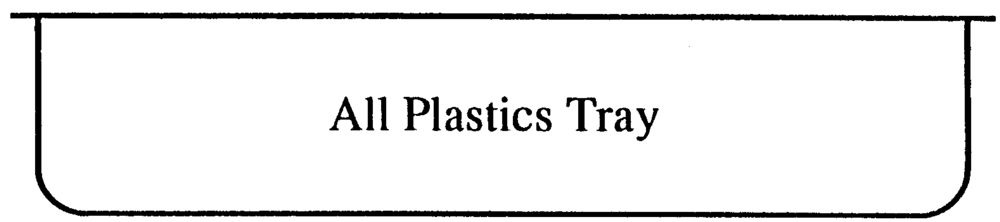
A. Journals

1. Journal of Plastic Film & Sheeting, 1989-1991.
2. Packaging Technology and Science, 1988-1991.
3. Packaging, 1988-1991.
4. Plastics Engineering, 1985-1991.
5. Food Processing, 1988-1991.

B. Selected References

1. Yam, K.L., J. Paik, C.C. Lai. 1992. Packaging: General Consideration. In Encyclopedia of Food Science and Technology.
2. Labuza, T.P. 1982. Shelf-Life Dating of Foods. Food & Nutrition Press, Connecticut.
3. Modern Plstics Encyclopedia. 1992. McGraw-Hill, New York.
4. Koros, W.J. 1990. Barrier Polymers and Structures: Overview. In Barrier Polymers and Structures, edited by W.J. Koros. ACS Symposium Series 423, pp. 1-22, American Chemical Society, Washington DC.
5. Tsai, B.C. and J.A. Wachtel. 1990. Barrier Properties of Ethylene-Vinyl Alcohol Copolymer in Retorted Plastic Food Containers. In Barrier Polymers and Structures, edited by W.J. Koros. ACS Symposium Series 423, pp.192-202, American Chemical Society, Washington DC.
6. Alger, M.M., T.J. Stanley, and J. Day. 1990. Retortable Food Packages Containing Water-Sensitive Oxygen Barrier.

Dimensions of Tray and Oxygen Transmission Rate Calculations



Tray

<u>Dimensions</u>:
Height: 50 mm
Length: 290 mm
Width: 240 mm
Surface Area: 0.1226 m^2

<u>Material</u>
EVOH type laminate

Premeability (cc.25μ/m^2 24 hr atm)
0.157 at 23 °C
0.394 at 35 °C

Lid

Plastic/foil lid

Zero Permeability

OTR

$$OTR = \frac{\bar{P}\,A}{\ell}\Delta P$$

$\bar{P}$ = oxygen permeability
ℓ = thickness of material
A = surface area of tray
ΔP = partial oxygen pressur
= 0.21 atm

Springborn Laboratories, Inc.
One Springborn Center, Enfield, Connecticut 06082-4899 • (203) 749-8371 • Telex 4436041 • Facsimile (203) 749-7533 • 749-82[illegible]

January 10, 1992

Attn: Mr. Neil Litman
Rutgers University

FAX No. 908 932-8690

Dear Neil:

It was a pleasure to talk to you yesterday regarding Springborn's past efforts in the development of a polymeric steam table food tray for U.S. Army Natick.

Tray Stock - The sheet stock used by Springborn for tray fabrication was a 7 layer, 60 mil Polypropylene/EVAL stock, supplied by American National Can Co. This is the same tray stock as used for Delmonti's Vegetable Classics. The exact sheet construction is as follows:

PP/R'gnd./Tie/EVAL/Tie/R'gnd./PP

PP	- Polypropylene
R'gnd.	- Tray Regrind
Tie	- Adhesive & Desiccant
EVAL	- Ethylene Vinyl Alcohol

The water and oxygen vapor transmission rates of the tray stock were reported by American National Can Co. as:

OTR = 0.05 cc/mil/100 in^2/24 hrs./1 atm. - not retorted

WVTR = 0.02 gms/100 in2/24 hrs. at 100°F and 90% R.H.

Currently Springborn has approximately 740 feet of 60 mil tray stock in storage left from the previous program, should you need it in your program.

Lid Stock - During the course of our program, we evaluated 2 different lid stock materials provided by American National Can, M-4850 and M-6262. The M-4850 is a 3 mil, polyester coated aluminum foil stock. The M-6262, a 4 layer construction that includes a 2 mil high barrier Saran layer. During retort processing we encountered slight delamination of the M-4850 lid stock using a 240°F, 75 minute retort cycle. It was concluded that the polyester had probably absorbed moisture causing the slight delamination. No effects from retorting were noted using the M-6262 microwavable lid stock.

The M-6262 lid stock is constructed as follows:

PET/Saran/PET/Coex

PET	- 48 gauge Polyester
Saran	- 2 mil High Barrier Saran
Coex	- 3 mil Adhesive

Springborn

The water and oxygen vapor transmission rates of the M-6262 lid stock were reported by American National Can Co. as:

$$OTR = 0.04 \text{ cc/mil/100 in}^2\text{/24 hrs./1 atm.}$$

$$WVTR = 0.75 \text{ gms/24 hrs./1 M}^2 \text{ at 100°F and 90\% R.H.}$$

The contacts used by Springborn at American National Can include:

Mr. John P. McNulty
Managing Director, Sales
Barrier Plastics Packaging
Performance Plastics Packaging Div.
Greenwich, CT
(203) 863-8141

John was our original point of contact who sold us the Tray and Lid stock material.

Mr. Frank Bauer
Flexible Packaging Research & Development
Performance Plastics Packaging Div.
Neenah, WI
(414) 727-6892

Frank was technically responsible for the Lid stock products.

Mr. Roger Genske
Performance Plastics Packaging Div.
Neenah, WI
(414) 727-6816

Roger was technically responsible for the Tray stock laminates.

On completion of our program, John McNulty informed us that to achieve a 3 year shelf life would require:

Assuming a 60 mil sheet for an 8½ x 11 inch tray.
- 4 mil EVOH with desiccant.
- 8 mil EVOH without desiccant.

Since the completion of our program, we have heard of a note worthy development coming from CMB Packaging Technology in Wantage, UK, Telephone No.: 011-44-235-77-2929. We have not had an opportunity to evaluate their technology.

CMB has apparently developed a high barrier material called Oxbar, a polyethylene terephthalate resin blended with MXD6 nylon (a barrier resin based on metaxylenediamine and adipic acid, from Mitsubishi Gas Chemical), and a cobalt salt. Oxbar, originally developed for plastic bottle applications, achieves a near total chemical barrier, rather than physical, through the initiation of an oxygen scavenging reaction within the container which is largely independent of environment. The reaction not only blocks oxygen from entering the container, but expunges it from within as well.

CMB claims OTR to be less than 0.003 cc.

Good luck with your new program and if we can be of any assistance in your program, please let us know.

Very truly yours,

SPRINGBORN LABORATORIES, INC.

James P. Galica

James P. Galica
Director, Materials Engineering & Information Services

February 20, 1992

CRAMTD

To: Files

From: Neal Litman

RE: STP #10 - Trip to Springborn Laboratories to discuss their effort developing a polymeric tray for Natick

Attendees: Springborn: James Galica, Director Materials Engineering
Rutgers: T. Descovich, K. Yam, P. Giannakakos, N. Litman

Springborn Laboratories was responsible for developing the prototype polymeric tray for Natick. Their effort included the development of a barrier composite and tray tooling mold.

We toured the facilities; material testing laboratories and small production plastics manufacturing equipment. The thermoformer used for making trays was quite out of date; possible problems will be non-uniform heating of the plastic and inadequate mold cooling. This may lead to uncontrollable variations in tray thickness and unacceptable test specimens. The Tooling for the tray was in good condition and can be modified for our development work. Springborn will send us drawings of the tooling. Natick must authorize our use of the tooling.

cc: T. Descovich

February 21, 1992

CRAMTD

To: Files

From: Neal Litman

RE: STP #10 - Trip to Natick to Present Report on Barrier Polymers

A meeting was held with Diane Wood of Natick to review progress. Prof. Yam presented the findings of the literature search. The highlights:

The information search included literature, industry, expert consultation.
Critical factors for obtaining "3 year shelf life": material, environment, tray design and food product.
An analysis of the Natick prototype tray predicts less than 3 year shelf life.
Oxygen permeability criteria needs to be defined.
Real-time shelf life test is necessary.
Desiccant in tie layer may cause blistering when microwaved.
EVOH filled with Mica is not thermoformable, there is no US tray manufacturer.
Silicon Dioxide coatings provide excellent barrier.
Recommendation: 1) define "3 year shelf life"
2) develop improved EVOH laminates
3) monitor developments in SiO_2 and mica technologies.

The work was well received by Diane and she agreed to review the report.

Tray manufacture was discussed. The thermoforming equipment at Springborn is old and may not produce consistent trays. Tooling for the Tiromat is too expensive for development work. Prof. Yam has experience with the Rutgers Packaging Department thermoformer. There may be outside tray producers such as American National Can. Diane will look into releasing Natick tray tooling for Rutgers use.

cc: T. Descovich

Comparison of Natick Prototype Polymeric Tray and Metal Tray Can

		Polymeric Tray	Tray Can
Empty Weight		105.2 gm	244.6 gm
Outside Dimension	width	10.06"	10.09"
	length	12.12"	12.32"
	height	2.01"	2.02"
Inside Dimension	height	1.85"	2.05"
	width @ bottom	8.5"	8.9"
	width @ top	9.4"	9.9"
	length @ bottom	10.5"	11.1"
	length @ top	11.5"	12.2"
Depth of Water	@ 1000 cc	.59"	.59"
	@ 2000 cc	1.21"	1.15"
	@ 2500 cc	1.48"	1.43"
	@ 2600 cc	1.54"	1.48"
	@ 2700 cc	1.59"	1.53"
	@ 2800 cc	1.63"	1.57"
	@ 2900 cc	1.68"	1.63"
	@ 3000 cc	1.74"	1.68"
	@ 3100 cc		1.75"
	@ 3200 cc		1.80"
	@ 3300 cc		1.83"
	@ 3400 cc		1.87"
	@ 3500 cc		1.91"
Maximum Tray Volume		3000 cc	3575 cc
Volume below tray knuckle		2575 cc	2415 cc
Comments:		flimsy tray flange width .17" flange twisted, inward bow, upward bow	rigid tray

The State University of New Jersey

RUTGERS

Cook College - Center for Advanced Food Technology

CRAMTD Program

Specifications

for

POLYMERIC TRAY SEALING MACHINE

This specification covers the requirements for a polymeric tray sealing machine that will be used for the CRAMTD Program under Short Term Project (STP) #10 - Rigid Polymeric Container Processing.

The machine will be used for the CRAMTD program demonstration site and for research and development of new packaging methods and materials.

This specification consists of the following sections.

1. Performance Requirements
2. Food Product Information
3. Package Information
4. Design Requirements
5. General
6. Acceptance
7. Shipping and Installation

1.0 Performance Requirements

1.1 Operational Duty. The equipment is to be capable of continuous operation in a typical food production environment. The equipment is to be reliable with a Minimum Operating Efficiency of 98%. Minimum Operating Efficiency is defined as percentage of time which equipment performs at specified rate. This equipment must operate in a typical washdown area and must withstand the use of non-caustic detergent, bleach and high pressure water cleaning. Cleaning time will be provided daily as required by regulatory agencies (i.e. FDA, USDA) or at least once per day.

1.2 Container Sealing. The equipment will evacuate air from the container to a vacuum level of 5 - 8 inches of Hg. The CRAMTD production facility has a Busch RA400 vacuum pump available for this purpose. The machine must seal the

lidstock without wrinkles or defects in the seal area. Excess lidstock is to be cut or punched and removed from the tray.

1.3 Production Rate. The equipment shall be capable of processing 30 half steam table trays per minute.

1.4 The tray sealer is to be supplied with tooling for handling the half steam table tray only.

2.0 Production Line Integration.

2.1 Container Infeed. The height of the production line is 48 inches above the floor. An "S" shaped infeed conveyor is to be included as shown in Drawing 1. The tray sealer is to be offset approximately 9 feet from the reject diverter conveyor (center to center). Gaps between trays may occur due the checkweigher/reject system. The tray sealer should be capable of either closing the gap without sloshing product or "no tray - no seal" operation. Trays must transfer smoothly from conveyors into carriers without slosh or tipping through the machine. The tray sealing machine will include a device for pressing food product to flange level.

2.2 Container Outfeed. An outfeed conveyor is not required.

2.3 Interface with Tray Line Controls. Start/Stop Control of line will be from Tray Line Control Panel. Production line speed will be controlled by the Master Motor Controller (Fenner M-Trim). Emergency stop or tray sealer failure condition is to be interfaced with tray line control cabinet.

3.0 Container Information

The sealing machine is to be designed to accommodate 3 tray sizes;

3.1 Half Steam Table Tray. Dimensions for the tray will be as shown in Drawing 2. The tray material is 60 mil thick laminated structure of polypropylene/EVOH/polypropylene. The lidstock material is 7 mil thick laminated structure of polyester/PVDC/polyethylene/polypropylene. Estimated sealing conditions are 220°C at 60 PSI for 6 seconds. Sealing parameters are to be determined independently from sample testing.

3.2 Forty (40) Ounce Tray. To be determined.

3.3 Ten (10) Ounce Tray. To be determined.

4.0 Design Requirements

4.1 Mechanical. Trays sealer will operate with a continuous motion. Vendor is to define all necessary equipment in the proposal. The sealer will be provided with a variable speed motor drive compatible with the Fenner controller.

4.2 Pneumatic service is available up to 100 PSI. Vendor to estimate air volume and pressure requirements.

4.3 Electrical. Vendor to estimate power and voltage requirements. All wiring, connections, control boxes, enclosures and components shall conform to NEMA 4 standards.

4.4 Controls. The equipment will be operated automatically.

4.5 Construction. USDA requirements for food handling equipment apply. Exterior of equipment may be stainless steel, metal covered with USDA approved white epoxy paint and anodized or coated aluminum.

4.6 Physical dimensions of the sealer, including location of utility hook-ups and weight are to be provided.

4.7 Cleanability. The vendor will make every effort to design equipment for easy cleaning, both internally and externally, and to be free from crevices.

4.8 Safety. The tray sealer will include features that provide protection to plant personnel. Applicable OSHA regulations must be observed.

4.9 Engineering Features. Parameters for tray sealing and air evacuation should be easily adjustable and reproducible.

5.0 General

5.1 Cost. The proposal is to include total cost F.O.B. Rutgers University, Food Science Building, Cook College, New Brunswick, NJ. Cost of optional equipment, recommended spare parts and accessories should be quoted but clearly delineated from base bid.

5.2 Delivery Schedule. The vendor will specify engineering design, fabrication, testing and delivery schedule.

5.3 Service. The vendor will provide service as needed to fulfill requirements of the warranty, installation and training.

5.4 Manuals. Equipment operational procedure and maintenance will be fully documented in a set of manuals.

5.5 Drawings, Photos. A layout drawing of this machine shall be provided in both plan and elevation views. Photos shall be provided as needed.

5.6 Award. The criteria for selecting a proposal will be based on the evaluation of the CRAMTD staff:

Delivery
Performance
Engineering Features
Cost
Service
Training

5.7 Exceptions. The vendor is to clearly identify any exceptions taken from these specifications.

5.8 Warranty. The vendor warranties the equipment performance specified herein for one year from the date of acceptance. The vendor will warrant the equipment is free from defects in materials and workmanship.

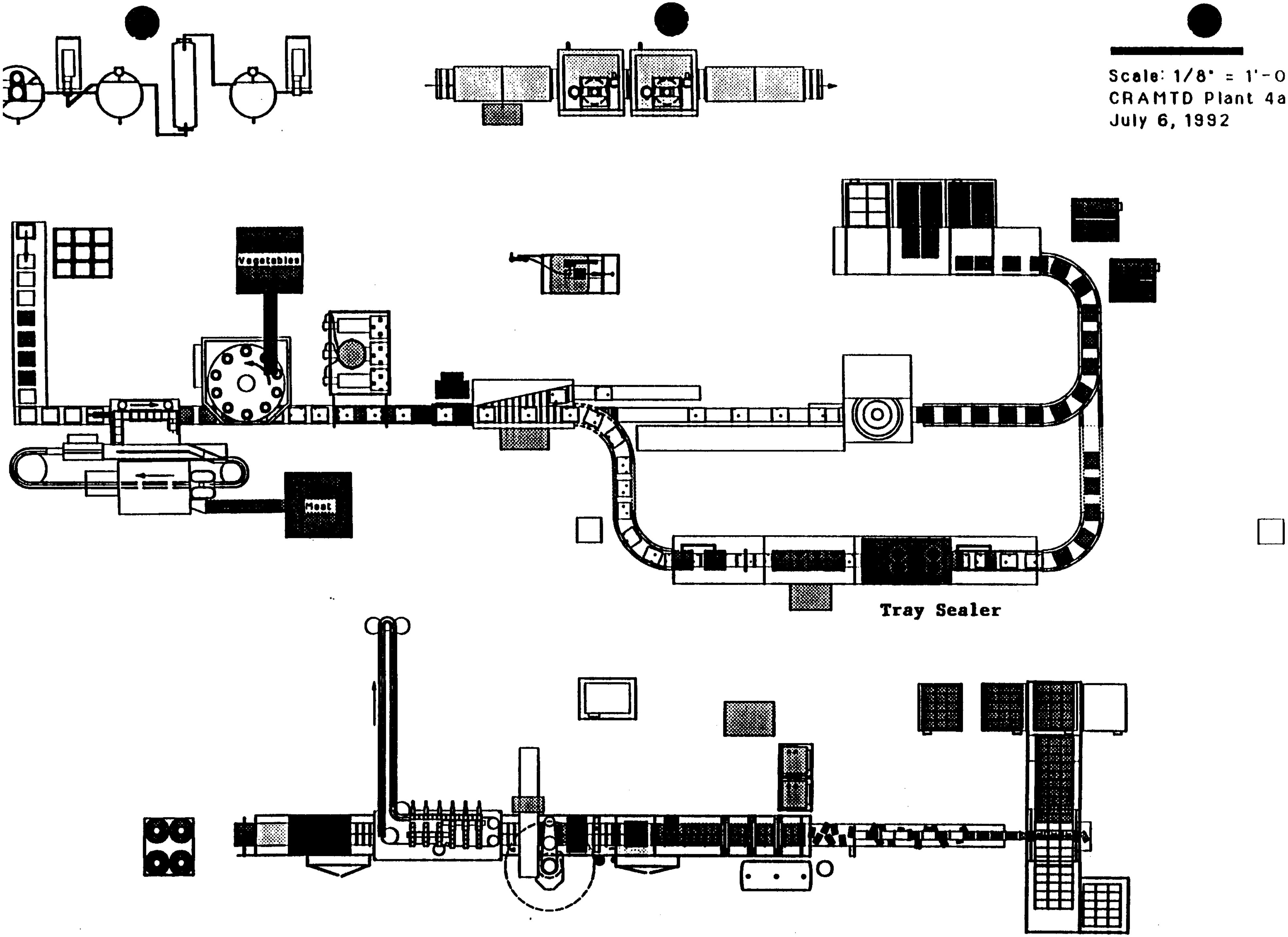
6.0 Acceptance

Acceptance Test. The equipment will be subject to an Acceptance Test to determine whether performance requirements have been met. A test may be run for up to one hour at 30 trays per minute.

7.0 Shipping and Installation

7.1 The equipment will be shipped F.O.B., Rutgers University, Food Science Building, CAFT, Cook College, New Brunswick, NJ 08903.

7.2 The vendor will assemble and install equipment in full working order and provide training to Rutgers personnel in the operation and maintenance of the equipment.


Scale: 1/8" = 1'-0"
CRAMTD Plant 4a
July 6, 1992
Vegetables
Meat
Tray Sealer

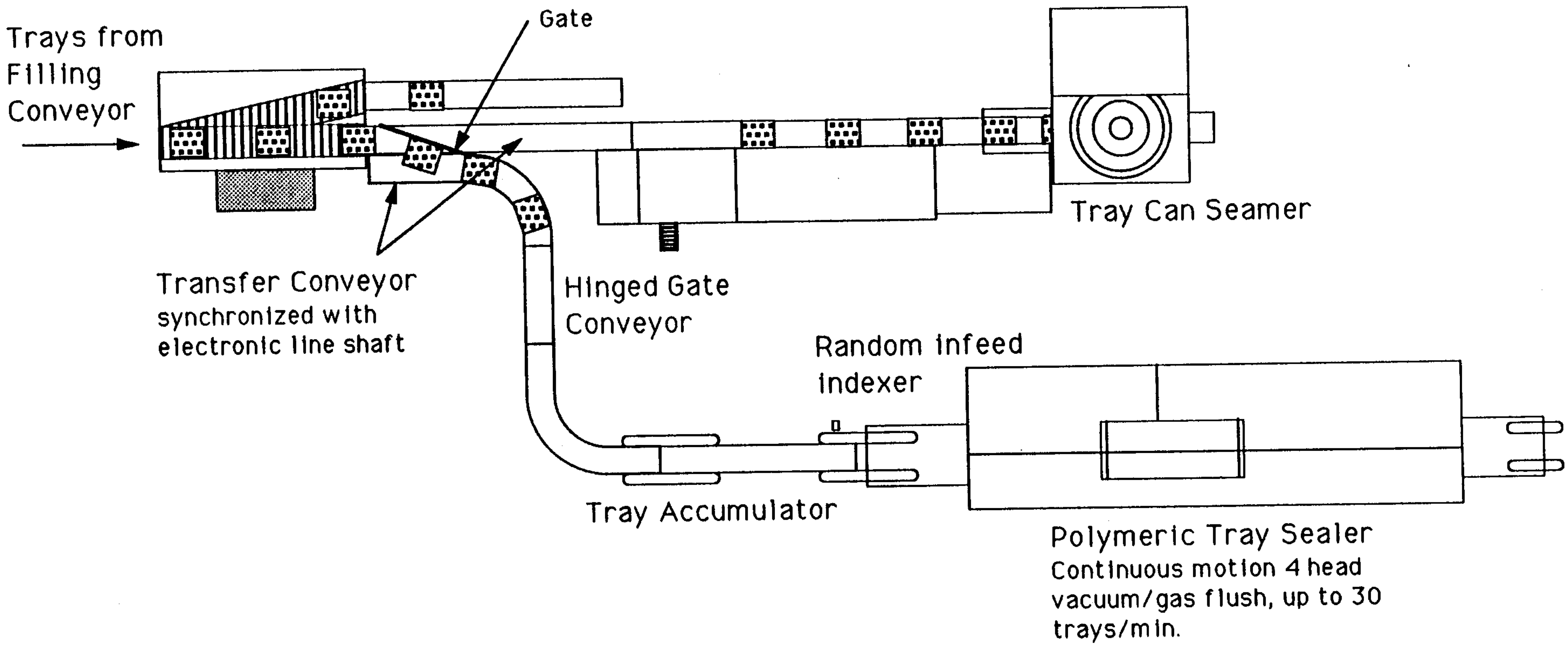
Drawing 1

Vendors for STP# 10 - Polymeric Tray Sealing Machine

Fords Holmatic, Inc.
6691 Jimmy Carter Blvd.
Norcross, GA 30071
Rep.: Joseph Poges
Rypac Packaging Machinery Inc.
27 Warren Cutting
Chester, NJ 07930

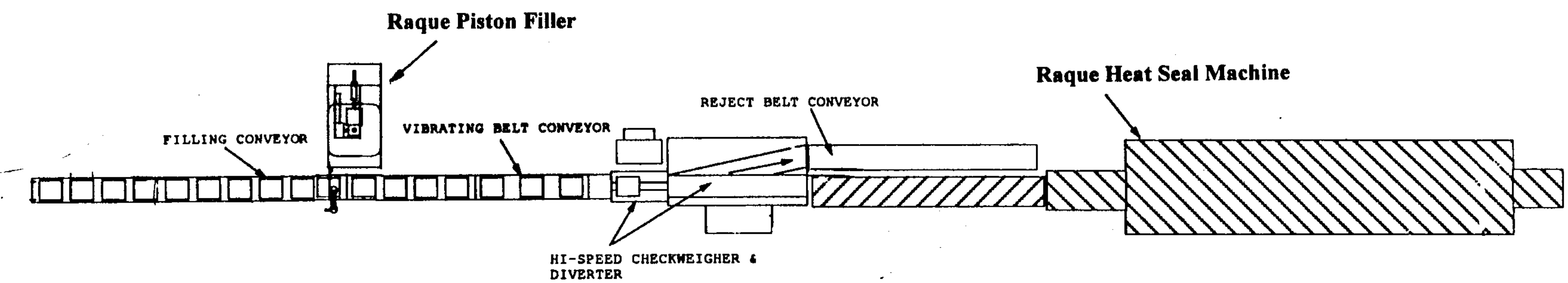
Food Equipment Manufacturing Corporation
22201 Aurora Road
Bedford Heights, OH 44146
Attn: Mike Mortier
216 663-1208

Raque Food Systems, Inc.
P.O. Box 99416
11002 Decimal Drive
Louisville, KY 40299
Attn: Jack Hayden
502 267-9641



Metal/Polymeric Half Steam Table Tray Line

RIGID POLYMERIC TRAY



HALF STEAM TABLE TRAY PACK PACKAGING LINE

Evaluation Heat Sealer

	VENDOR EVALUATIONS			RFQ- 2-7-16-1	
Evaluation Criteria	% weight	Score	Raque	Score	FEMC
Delivery	15	12	5 months	15	4 months
Cost	20	10	$340630- Change parts $12,500 each	5	$395000 -Change parts $15,000 each
Service	5	5	Included	2	Not in proposal
Training	5	5	Included	2	Not in proposal
Engineering Features	30	25	4 head heat seal machine	10	6 head heat seal machine
			Meets specifications		No hinged conveyor
			Side transfer to heat sealer		Conn. conv.to seamer not included
			Hinged sealing head assembly		Inclined conv.- product spilling
			Automatic speed adjustment		Not sufficient engineering info
					No provision for transfer
Performance	25	25	Meets specifications - 30/min.	25	Meets specifications - 30/min.
TOTAL	100	82		59	

Raque
FOOD SYSTEMS, INC.
11002 DECIMAL DR.
P. O. BOX 99594
LOUISVILLE, KY. 40269-0594
FAX # 502-267-2352
TELEPHONE 502/267-9641

August 10, 1993

Mr. Ted Descovich
CAFT/Food Manufacturing Technology Facility
120 New England Avenue
Piscataway, New Jersey 08854

Dear Ted:

Please find enclosed a revised heat seal machine proposal for the half size steam table tray with vacuum feature and tray accumulator with index transfer. The proposed sealer to run up to 30 containers per minute.

Please call if you have any questions or need additional information.

Sincerely,

Jack Hayden

Jack Hayden
Sales Application Engineer

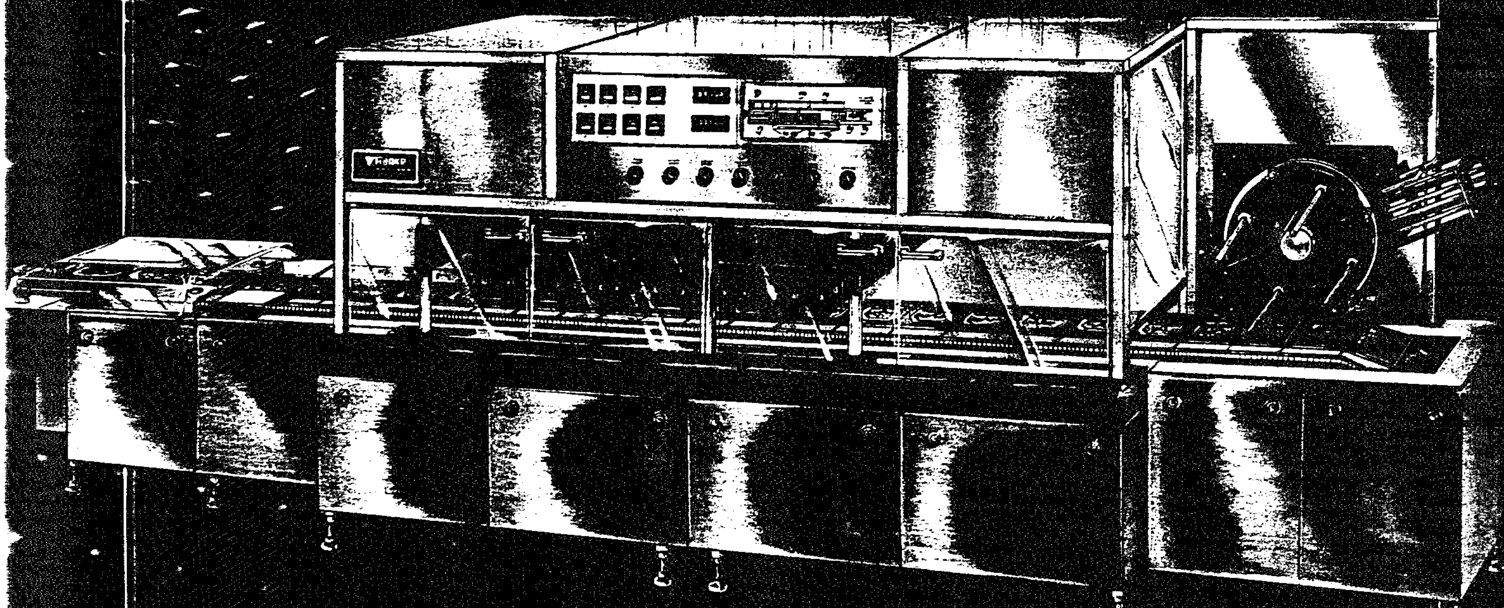
JH:dkm

Enclosure

Raque Food Systems

INTRODUCES

Sealing Technology of the 90's



HSL - 100

STP #10

Automatic Sealing System using printed board containers and lids with single and multiple compartments.

Model HSL-100 Heat Sealer	Sealing and Filling Systems
• Reduced packaging • Dual ovenable • Easy open lid • Single lane and dual lane design • Single lane – 125 packages/minute • Dual lane – 250 packages/minute • Easy changeover to different size and shape packages • Modified atmosphere available • U.S.D.A. Approved	• Turnkey automatic systems up to 250 containers per minute. • Tray dispensers for ovenable board containers. • Piston fillers for liquids with particulates and viscous materials. Piston fillers supplied with static hoppers, horizontal blending hoppers, and auger hoppers. • Rotary plate fillers for vegetables and free flowing dry products. • Fillers for garnish toppings, such as shredded cheese, bread crumbs, etc. • Rotary pump fillers for gravies and butter coverage of vegetables. • Freezer infeeds and freezer outfeeds. • Check weigher controlled fillers. • Scale weigh fillers.

Raque
FOOD SYSTEMS, INC.

Raque Food Systems, Inc.
11002 Decimal Drive
P.O. Box 99594
Louisville, KY 40299
Telephone: (502) 267-9641
Fax: (502) 267-2352

Raque Food Systems Europe
Dieselstrabe 8
D5480 Remagen 1
Germany
Telephone: (49) 26 42 / 2 30 99
Fax: (49) 26 42 / 2 20 38

Raque
FOOD SYSTEMS, INC.

Sales Proposal #: 5441
Date: August 10, 1993

TO: CAFT/Food Manufacturing Technology Facility
120 New England Avenue
Piscataway, New Jersey 08854

SINGLE LANE CONTINUOUS MOTION HEAT SEAL LINE WITH VACUUM FEATURE

CONTAINER:	12 3/4" X 10 3/8" X 2 1/2" DEEP PLASTIC
PRODUCT:	1/2" TO 3/4" CUBED
LID MATERIAL:	FILM FROM ROLL STOCK - DIE CUT IN SEALER
SPEED:	30 CONTAINERS PER MINUTE
NOTE:	VACUUM SUPPLY SYSTEM BY CAFT.
REFERENCE:	RFQ-2-7-16-1

ALL CONVEYOR ELEVATIONS 48" TO BOTTOM OF CONTAINER FROM FLOOR.

1 RAQUE MODEL HS-100 SINGLE LANE CONTINUOUS MOTION HEAT SEAL MACHINE WITH THE FOLLOWING:

A) DUAL MOTION SEALING HEAD ASSEMBLY HAVING THREE (3) VACUUM CHAMBERS EACH WITH ONE (1) SEALING HEAD ASSEMBLY FOR ONE SIZE CONTAINER.

B) OSCILLATING MOTION FILM DIE CUT AND TRIM REWIND ASSEMBLY.

C) TWO (2) FILM MANDRELS.

E) DIGITAL TEMPERATURE READOUT EACH SEALING HEAD.

F) AUTOMATIC SPEED ADJUSTMENT TIE-IN TO ACCUMULATOR CONVEYOR.

G) THREE (3) THREE STAGE AIR CYLINDERS ONE (1) EACH SEALING HEAD. EACH CYLINDER CAN PRODUCE UP TO 6,849 POUNDS OF FORCE AT 80 PSIG ON CONTAINER FLANGE SEAL AREA.

H) CONTAINER LIFTER AND DISCHARGE TRANSFER ASSEMBLIES. LIFTER PLATES FOR ONE SIZE CONTAINER.

TO: CAFT/Food Manufacturing Technology Facility
120 New England Avenue
Piscataway, New Jersey 08854

I) TWO HORSE POWER VARIABLE SPEED A.C. DRIVE MOTOR COMPLETE WITH 1 1/2" DIAMETER LINE SHAFT. BEARINGS AND GEAR BOXES.

J) CLUSTER LUBRICATION WHERE REQUIRED.

K) HEAT SEALER FRAME CONSTRUCTED OF 304 STAINLESS STEEL AND HARD COATED ALUMINUM. FRAME MOUNTED ON ADJUSTABLE FEET. ALL WELDS GROUND AND POLISHED.

L) ELECTRICAL, 230V, 3 PH, 60 HZ. 40 AMP SERVICE ALL PNEUMATIC AND ELECTRICAL CONTROLS MOUNTED IN A NEMA 4 STAINLESS STEEL ENCLOSURE.

M) AIR REQUIREMENT 50 SCFM AT 80 PI.

N) EMERGENCY STOPS.

O) ACCUMULATOR CONVEYOR WITH RANDOM INDEX TRANSFER.

P) FAIL SAFE REDUNDANT SEALING HEAD PNEUMATIC VALVING SYSTEM.

PRICE: $249,995.00

NOTE: SEALING HEAD ASSEMBLY IS HINGED AND HAS LOCKING FEATURE FOR MAINTENANCE.

FOOD SYSTEMS, INC.

Sales Proposal #: 5441
Date: August 10, 1993

TO: CAFT/Food Manufacturing Technology Facility
120 New England Avenue
Piscataway, New Jersey 08854

NOTE: CAFT/FOOD MANUFACTURING TECHNOLOGY FACILITY HAS THE RESPONSIBILITY TO HAVE ALL MACHINERY LOCATED IN PLACE. RAQUE'S RESPONSIBILITY WILL BE TO HOOK UP RAQUE MACHINERY, START UP AND TRAIN CAFT PERSONNEL TO OPERATE MACHINERY.

PRICE:	$ 12,540.00
FULL LOAD FREIGHT COST:	$ 1,110.00
SKIDDING:	$ 1,200.00

F.O.B. CAFT/FOOD MANUFACTURING
120 NEW ENGLAND AVENUE
PISCATOWAY, NJ 08854

11002 DECIMAL DR. • P.O. BOX 99594 • LOUISVILLE, KY. 40269-0594
TELEPHONE (502) 267-9641 • FAX (502) 267-2352

Raque FOOD SYSTEMS, INC.

RAQUE FOOD SYSTEMS SERVICE RATES

The following field service rates are effective immediately:

Travel Time:	**$ 40.00 Per Hour**
Raque Daily Rates (Monday - Friday):	**$400.00**
Raque Saturday Rates:	**$600.00**
Raque Sunday and Holidays:	**$800.00**

The above rates are based on an 8-hour work day. Days that exceed eight hours will be calculated at the following overtime rates:

Daily Overtime Rates:	**$ 75.00 Per Hour**
Saturday Rates:	**$ 75.00 Per Hour**
Sunday and Holiday Rates:	**$100.00 Per Hour**

The above rates are in addition to all travel and living expenses.

This Offer Is Valid For Thirty (30) Days.

Terms: 35% Down, 55% Prior To Shipment, 10% Net 30 Days.

Shipment: 5 Months From Receipt Of Purchase Order And Downpayment.

F.O.B.: Louisville, Kentucky

This proposal shall become the agreement between Raque Food Systems, Inc. and the buyer and shall include all contents of this proposal.

Submitted Jack Hayden
Jack Hayden, Sales Application Engineer

APPROVED:
RAQUE FOOD SYSTEMS, INC.

By Edward A. Robinson

Title Edward A. Robinson, Vice-President

Date August 10, 1993

Purchaser

By

Title

Date

RAQUE FOOD SYSTEMS, INC.
TERMS OF SALE
CONDITIONS AND SERVICE POLICIES

SECTION NO. 1 - TERMS

1.1 Payment to be made in full within thirty (30) days after the date of delivery. Until full payment is made, title to and right of possession of the goods remains with the manufacturer. Any risk of loss or damage to the goods is born by the purchaser from date of shipment.

1.2 Purchaser shall pay the full purchase price within thirty (30) days after the goods have been completed; and, in addition, shall pay a reasonable storage charge as determined by the Seller. Any balance not paid when due shall draw interest at the rate of 1.5% per month on the average daily balance until paid. Purchaser shall pay all attorney's fees and court costs incurred by seller in collecting any unpaid balance. All payments shall be made in U.S. dollars.

SECTION NO. 2 - PRICES - TAXES

2.1 All prices are **F.O.B.** our factory, and are subject to change without notice at any time prior to acceptance of order.

2.2 The manufacturer will not be liable for any taxes or duties levied before or after the delivery of the equipment.

SECTION NO. 3 - TESTING AND INSPECTION

3.1 Purchaser is to inspect and test the equipment in the manufacturer's plant to assure itself that the equipment meets its specifications and approval before shipment. In event Purchaser waives inspection, it must advise manufacturer of its decision in writing and agree to accept the manufacturer's statement that the shipment has been tested and found to meet Purchaser's specifications, and such failure of Purchaser to inspect equipment hereunder prior to shipment will be construed as acceptance of equipment.

3.2 The materials furnished are to be the same as those Purchaser intends to use in the operation of the equipment.

SECTION NO. 4 - DELIVERY

4.1 All risk of damage to or loss of the machine(s) hereunder at any time after shipment thereof is assumed by Purchaser. Purchaser is responsible for insurance covering shipment and shall make all claims for damage resulting from mishandling during shipment, unloading, installation and testing of equipment in Purchaser's facility.

4.2 All delivery dates submitted in quotations are subject to prior scheduling.

4.3 Firm delivery dates must be confirmed by Purchaser at time purchase order is placed and are subject to delays caused by fires, Acts of God and accidents or other delays unavoidable or beyond our control.

SECTION NO. 5 - INSTALLATION AND START-UP

5.1 The Purchaser is responsible for uncrating, placing and setting the equipment in its final location and making utility connections required to operate the equipment.

5.2 All necessary labor, materials, supplies and utilities in sufficient quantities for start up, testing and operation of the equipment or testing of the equipment..

5.3 Under no circumstances whatsoever will the manufacturer be held liable for consequential damages, including, but not by way of limitation, any loss of time, materials or production as a result of late delivery, setting up, malfunctioning or operation of the equipment or testing of the equipment.

SECTION NO. 6 - SERVICE - DOMESTIC

6.1 Manufacturer will supply the service of one (1) service man at the prevailing rate per day or any part thereof to assist purchaser in the initial start-up of the equipment unless otherwise specified. The purchaser is to pay all living and traveling expenses, travel time to be considered as service time. Purchaser to give seller ten (10) days notice if this service will be required.

11002 DECIMAL DR. • P.O. BOX 99594 • LOUISVILLE, KY. 40269-0594
TELEPHONE (502) 267-9641 • FAX (502) 267-2352

6.2 SPARE AND/OR SERVICE PARTS - Orders for spare and/or service parts must be ordered on purchaser's regular purchase order form. If order given verbally, an order number must be given and confirmed by purchaser's regular purchase order and all parts subsequently ordered are subject to WARRANTIES LIMITATIONS set forth in Section 8 hereof terms of purchase order to the contrary notwithstanding.

SECTION NO. 7 - MAINTENANCE AND SERVICE MANUAL

7.1 Two (2) copies of "Operating and Maintenance Instructions" are supplied with each machine. Additional copies may be obtained at an extra cost.

SECTION NO. 8 - WARRANTIES

8.1 MATERIAL AND WORKMANSHIP - All machines are guaranteed against defects in material or workmanship for a period of one-hundred and eighty (180) days from date of installation in initial purchaser's plant. The results of ordinary wear and tear, improper operation or maintenance, including, but not by way of limitation, use of corrosive or abrasive materials shall not be considered a defect in workmanship or material. No claim by Purchaser for damages, labor or installation charges will be allowed.

8.2 The manufacturer will be relieved of all guarantees in the event that the equipment is altered by the purchaser without written permission from the manufacturer.

8.3 THE ABOVE GUARANTEE IS IN LIEU OF ALL OTHER GUARANTEES AND WARRANTIES, INCLUDING, BUT NOT LIMITED TO WARRANTIES OF FITNESS AND MERCHANTABILITY, BOTH EXPRESSED AND IMPLIED.

8.4 This warranty does not extend to products not of seller's manufacture, as to such products, seller conveys to purchaser the warranty, if any, of seller's supplier.

SECTION NO. 9 - SPECIFICATION AND DESIGN

9.1 Raque Food Systems reserves the right to make modifications in machine design prior to shipment without prior notice to seller.

SECTION NO. 10 - OCCUPATIONAL SAFETY AND HEALTH ACT OF 1970

10.1 Manufacturer will endeavor to comply with applicable specific standards for machinery which are incorporated in the Occupational Safety and Health Act of 1970 ("OSHA") and, to the extent known to it, with state safety regulations which are in effect at its manufacturing location, provided, however, that the purchaser has cited to us in its order or inquiry the specific section numbers of the standards with which it requests compliance.

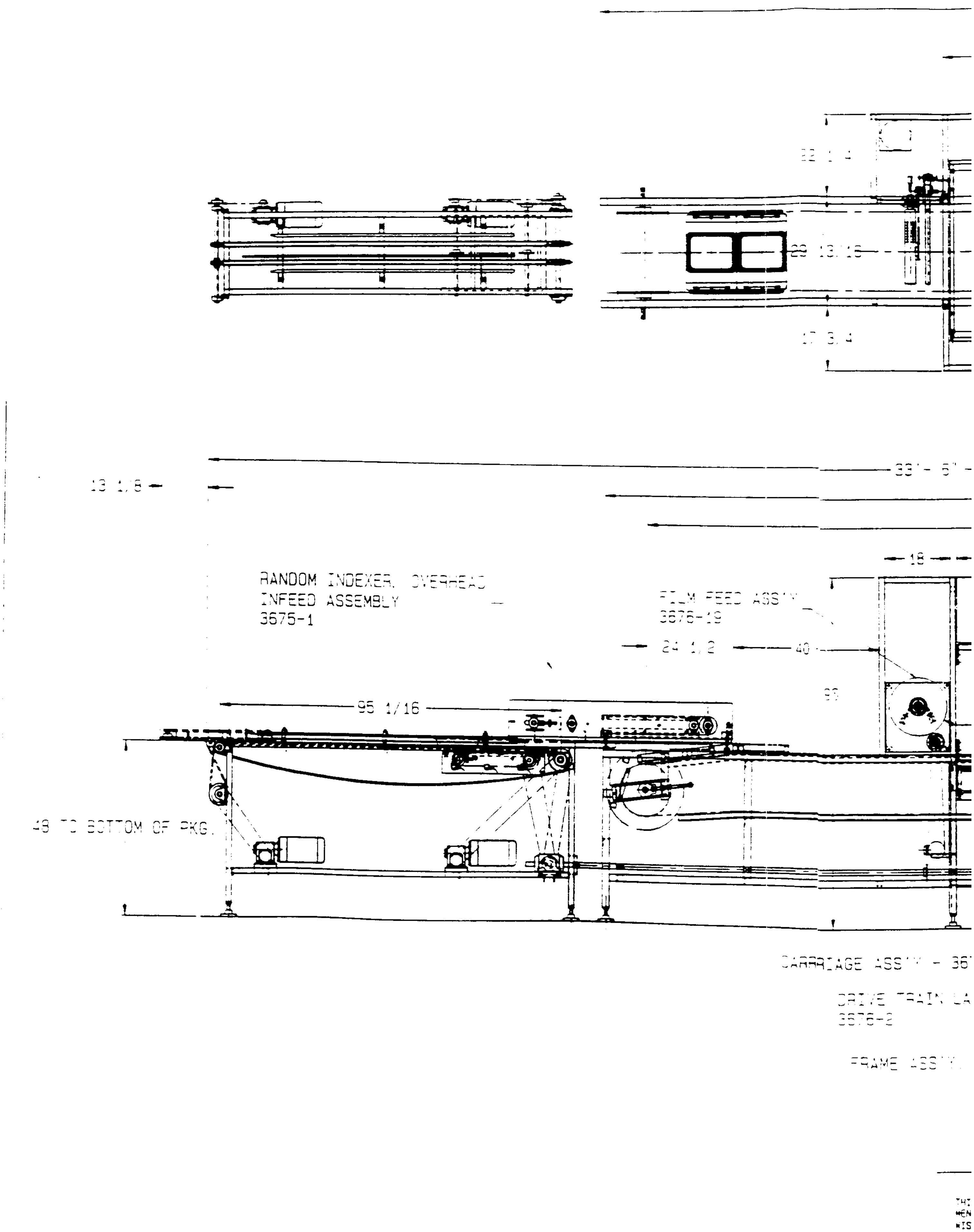
10.2 The price charged for the machines does not include a charge for compliance with such standards and state or local safety regulations, and in no event shall manufacturer be liable for any direct, incidental or consequential damages arising out of or resulting from non-compliance therewith. In the event, however, that such products are found not to comply, upon purchaser's request and at purchaser's expense, manufacturer will, if technically feasible, undertake modifications to make such products comply.

SECTION NO. 11 - CANCELLATION

11.1 The purchaser may cancel an order only by written notice to Raque Food Systems, Incorporated. In the event of such a cancellation, any items which, upon the receipt of cancellation notice, are within forty-five (45) calendar days of completion will be paid for in full by the purchaser. All items not within forty-five (45) days of completion shall be paid for on the basis of actual cost of labor, materials and supplies applied to the production of such items and overhead expenses determined in accordance with good accounting practice, as determined by the auditors of Raque Food Systems, Inc., plus 12% of such cost and expenses, provided that such cost and expense, plus 12% shall in no case, exceed 100% of the quoted price of such items.

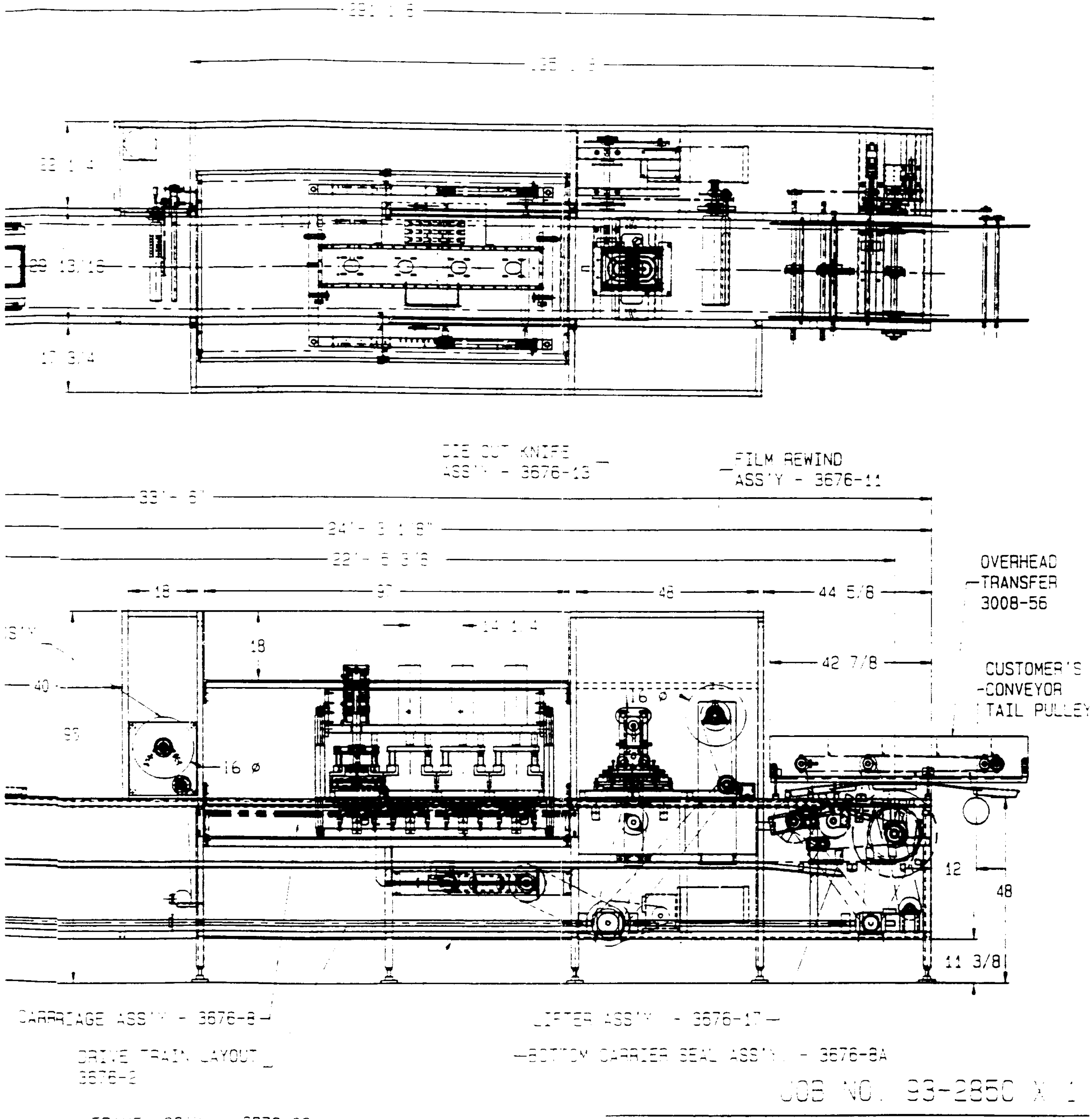
SHOULD ANY QUESTIONS ARISE REGARDING THE ABOVE TERMS AND CONDITIONS, THEY MUST BE RESOLVED BY THE MANUFACTURER AND PURCHASER IN WRITING BEFORE WORK ON THE ORDER IS BEGUN.

11002 DECIMAL DR. • P.O. BOX 99594 • LOUISVILLE, KY. 40269-0594
TELEPHONE (502) 267-9641 • FAX (502) 267-2352



22 1/4
29 13/16
17 3/4
13 1/8
33'- 6"
18
RANDOM INDEXER, OVERHEAD
INFEED ASSEMBLY
3675-1
FILM FEED ASS'Y
3676-19
24 1/2
40
93
95 1/16
48 TO BOTTOM OF PKG.
CARRIAGE ASS'Y - 36
DRIVE TRAIN LA
3676-2
FRAME ASS'Y

Figure 2



JOB NO. 93-2850 X 1

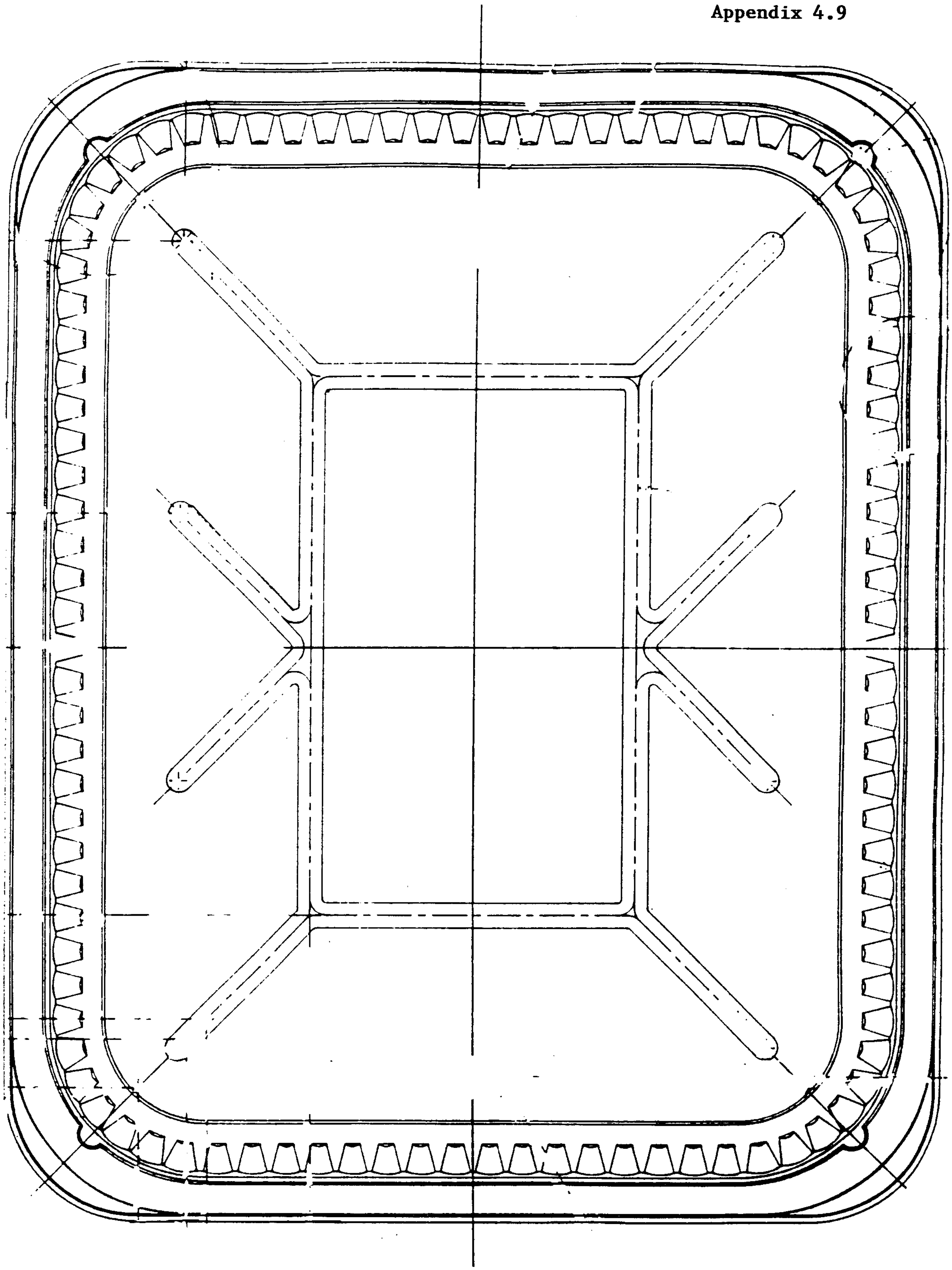
TOLERANCES (EXCEPT AS NOTED)
DECIMAL +/- .005
FRACTIONAL +/- 1/32
ANGULAR +/- 0 30'

APPROVED

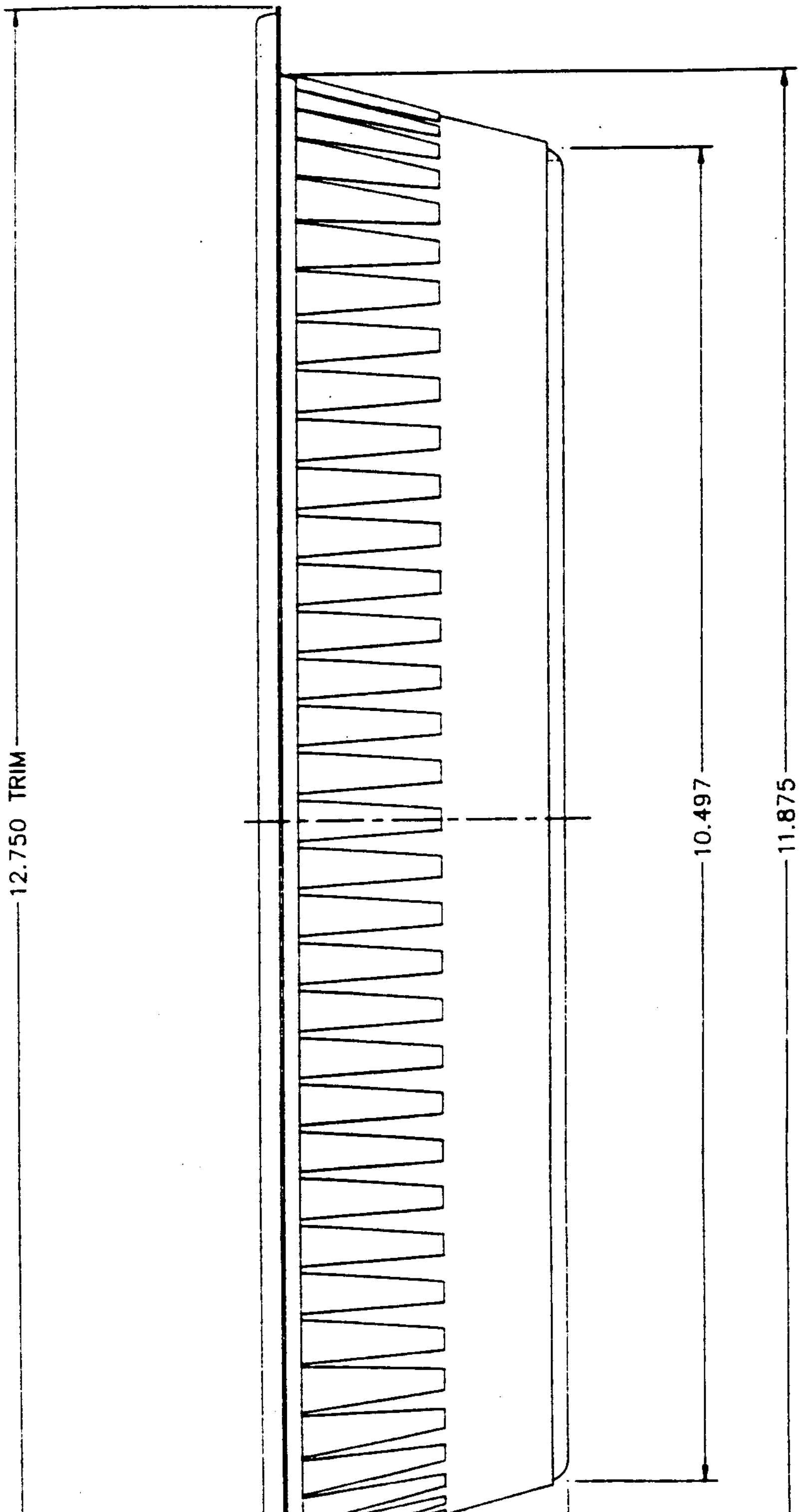
DATE

Raque FOOD SYSTEMS, INC.

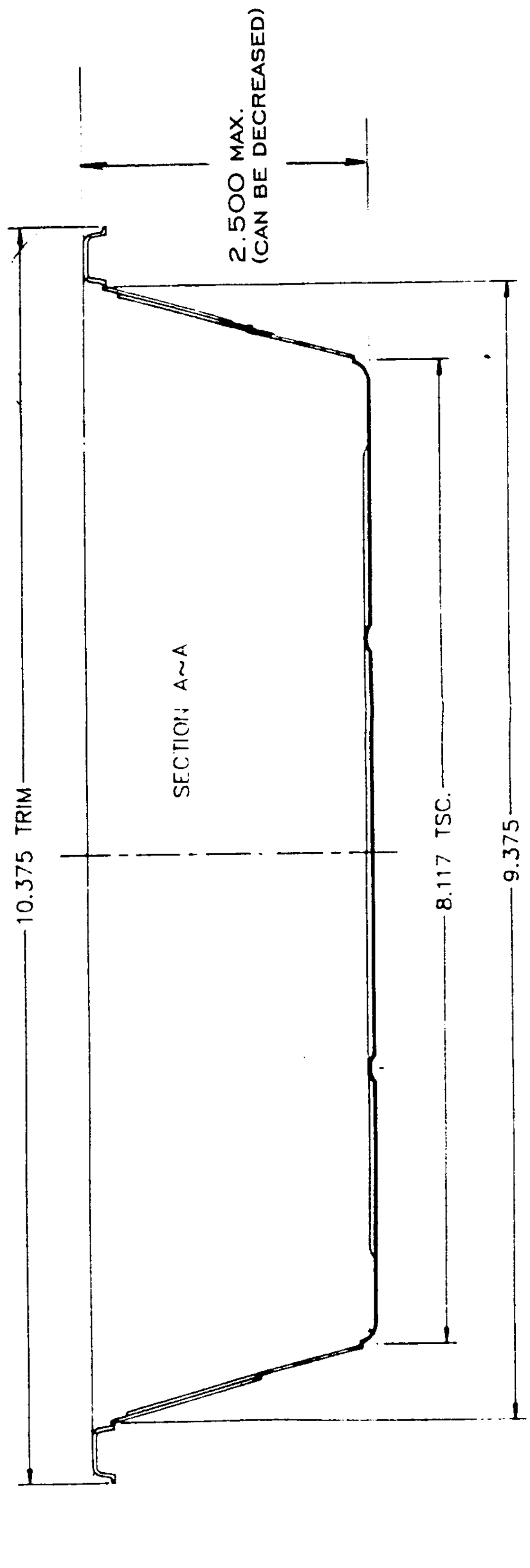
TITLE
4 HEAD HEAT SEAL ASSEMBLY
CAFT/FOOD MANUFACTURING TECHNOLOGY FACILITY
RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY



Mullinix Tray

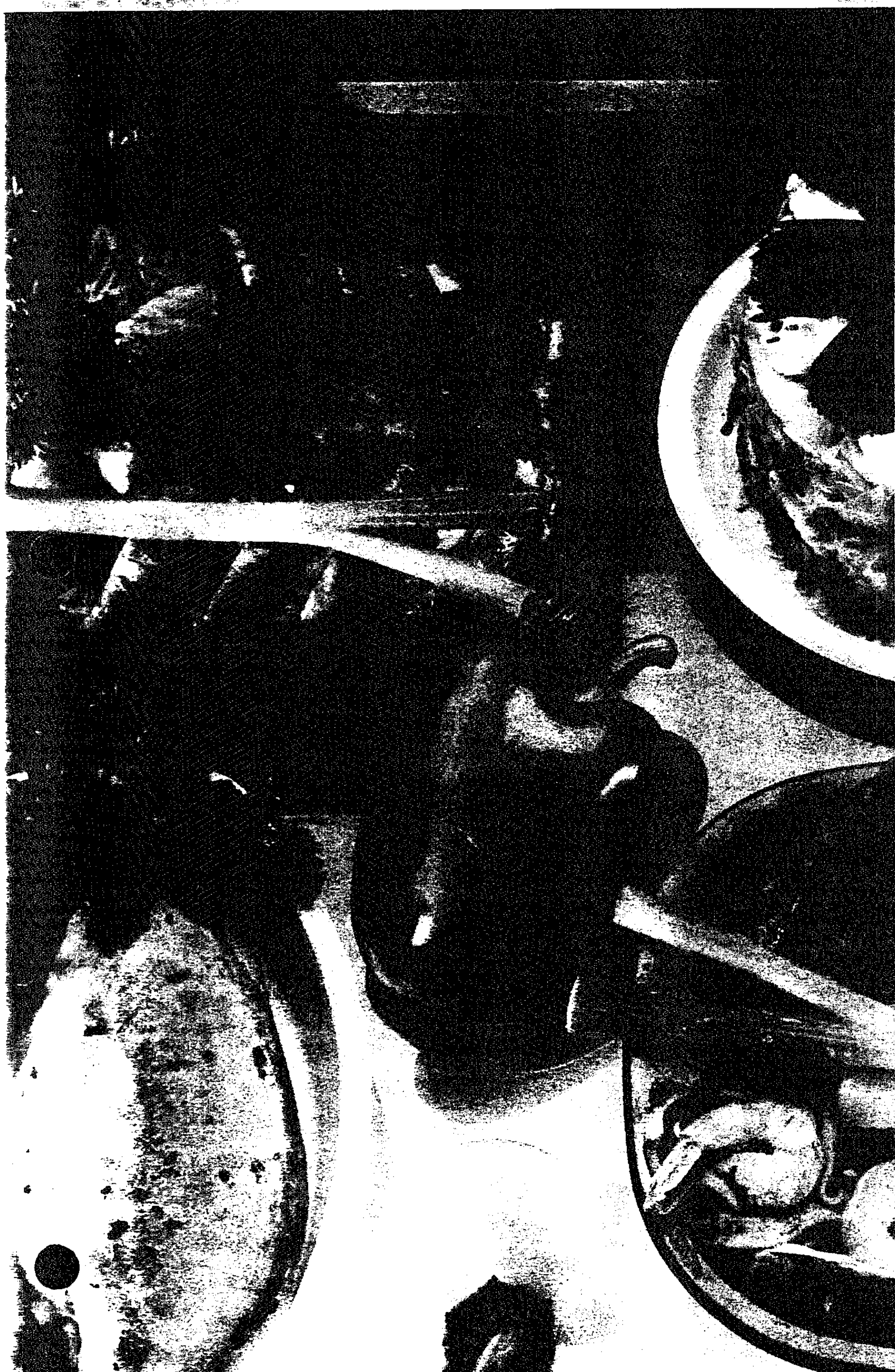


Mullinix Tray



Mullinix Tray

Convenient Excellence



mullinix Packages, Inc., brings convenience and durability to plastic food packaging. A quality producer of CPET food containers, Mullinix designs and thermoforms dual-ovenable packaging at cost-competitive prices.

The unique advantages of CPET packaging include:

- ***Convenience:***
  Dual-ovenability – from freezer, to microwave or conventional oven, to table.

- ***Cosmetic appearance:***
  Designs to enhance your dining decor or complement any lifestyle.

Mullinix introduced CPET food trays to the airline industry in 1983 and the food industry in 1984. Further, the company was the first to co-extrude CPET with a virgin amorphous layer for a superior sealing surface, no contaminants to come in contact with food, and increased cold-temperature impact strength.

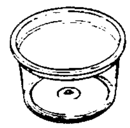
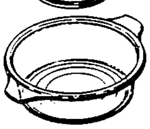
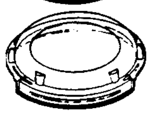
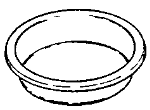
Mullinix cares about its customers and works with them from design through final production. An extensive range of containers, as shown on the reverse side, is also available in stock for quick delivery. Whether custom design or stock items, Mullinix can supply your packaging needs, quickly and efficiently.

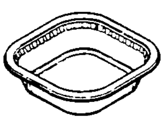
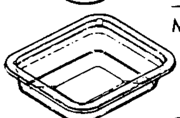
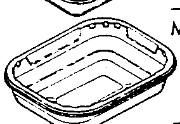
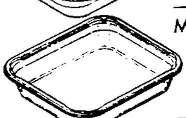
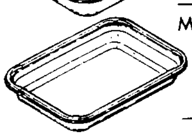
Mullinix Packages, Inc.
3511 Engle Road
Fort Wayne, Indiana 46809
Phone: 219 747 3149
Fax: 219 747 1598

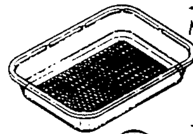
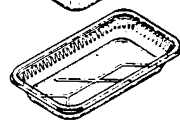
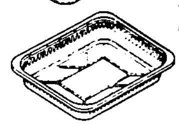
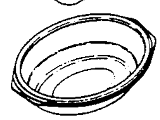
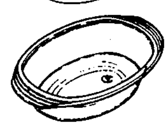
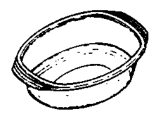
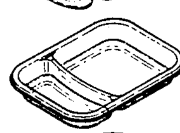
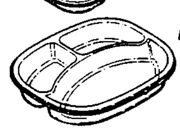
mullinix

CPET Line

SPECIFICATIONS

	PART ID #	TOP DIA.	HEIGHT	APPROX. FLUID CAPACITY
	MX3000-16	3.000	1.570	4.09 OZ.
	MX3000-19	3.000	1.935	4.89 OZ.
	MX5061-19	4.985	1.875	11.00 OZ.
	MX5200-09	4.932	0.926	(Polypropylene Lid for MX5061-19)
	MX7200-15	7.188	1.500	22.75 OZ.
	MX7900-08	7.938	0.818	16.25 OZ.

	PART ID #	TOP WIDTH	TOP LENGTH	HEIGHT	APPROX. FLUID CAPICITY
	MX4343-12	4.312	4.312	1.250	10.50 OZ.
	MX5060-14	5.00	6.00	1.375	15.00 OZ.
	MX5066-15	5.00	6.625	1.500	18.50 OZ.
	MX6275-14	6.250	7.500	1.375	26.75 OZ.
	MX6290-15	6.250	9.000	1.500	32.75 OZ.

	PART ID #	TOP WIDTH	TOP LENGTH	HEIGHT	APPROX. FLUID CAPICITY
	MX84120-18	8.375	12.000	1.812	67.50 OZ.
	MX69128-18	6.875	12.750	1.805	48.00 OZ.
	MX104128-17	10.375	12.750	1.750	81.375 OZ.
	MX5170-13	5.125	7.000	1.281	13.00 OZ.
	MX5279-14	5.258	7.884	1.375	16.00 OZ.
	MX6088-15	5.961	8.800	1.500	22.25 OZ.
	MX6088-12	5.960	8.800	1.224	LARGE=6.750 OZ. SMALL=5.500 OZ. ea.
	MX6290-11	6.250	9.000	1.125	LARGE=15.25 OZ. SMALL=6.50 OZ.
	MX7090-12-3	7.000	9.000	1.250	LARGE=14.50 OZ. SMALL= 5.4 OZ. ea.

- COLORS: black, bone & ivory
- Many OPS domes available upon request
- Also available in APET for non microwave/oven use
- Please call Mullinix for other sizes and depths available

SAMPLE REQUEST FORM

Fax this request form to Mullinix at: 219 747 1598

Yes. I am interested in Mullinix packaging concepts.

☐ Have a Salesman call ☐ Send more information ☐ Send samples

Contact person: __________

Company Name: __________

Shipping Address: Street: __________

City: _____ State _____ Zip _____

Phone: _____ Fax: _____

Mailing Address: Street: __________

City _____ State _____ Zip _____

Please send the following samples:

Package description (Part ID. #)	Quantity

Notes: __________

BURST TEST RESULTS

Lidding Material - Rollprint (refer to Rollprint Technical Info Sheet)

- Standard Mullinix tray
- 395oF - Seal time = 2 seconds
- Average burst test results = **2.3 psi**

- Modified flange area tray
- 395oF - Seal time = 2 seconds
- Average burst test results = **4.3 psi**

- Modified flange area tray
- 405oF - Seal time = 4 seconds
- Average burst test results = **5.7 psi**

Lidding Material - Heat Seal (refer to Heat Seal letter)

- Modified flange area tray
- 405oF - Seal time = 4 seconds
- Average burst test results = **6 psi**

Product and Technical Information

ROLLPRINT
ROLLPRINT PACKAGING PRODUCTS, INC.

Technical Data Sheet
RPP #26-1091

GENERAL DESCRIPTION: This composite is a proprietary heat seal coated tri-laminate consisting of 0.75 mil oriented polyester, 2.0 mil aluminum foil, and 1.5 mil of a proprietary heat and chemical resistant Rollprint heat seal coating. The polyester outer ply material provides strength and durability, tear resistance, plus dimensional and thermal stability. The middle foil ply provides total barrier properties, metal appearance, and adds to stiffness and rigidity. The coating provides strong, peelable heat seals to rigid PET containers.

STRUCTURE: .75 mil PET/2 mil Foil/1.5 mil heat seal

PROPERTY	UNITS	TYPICAL VALUE	TEST METHOD
Thickness	mils	4.4	RPP T-03101
Basis Weight	lb/ream*	130.3	RPP T-03311
Yield	in^2/lb	3,315	RPP T-03312
WVTR	$g/100\ in^2/24\ hr$	≈0.0	RPP T-02201
O_2TR	$cc/100\ in^2/24\ hr$	≈0.0	RPP T-02101

*Ream equals 432,000 in^2 (24 x 36 x 500)

NOTE: These values are typical for our RPP #26-1091 composite and are not intended for use as limiting specifications. For additional information, contact your Rollprint representative.

F.D.A. Status: RPP #26-1091 and other laminates and composites produced and sold by Rollprint Packaging Products comply with F.D.A. regulations and standards.

JFA:lf 12/95

Post-it® Fax Note 7671	Date 12-6	# of pages ▶ 1
To Neal Litman	From Joe Abelarde	
Co./Dept. Rutgers	Co. Rollprint Pkg.	
Phone #	Phone #	
Fax #	Fax #	

320 Stewart Avenue
Addison, IL 60101-3375
Phone: (708) 628-1700
Fax: (708) 628-8510

P.O. Box 510
5701 Berkshire Valley Rd.
Oak Ridge, N.J. 07438-0510
TEL: (201) 697-8888
FAX: (201) 697-1331

Heat Seal
PACKAGING INC.

November 8, 1995

Mr. Neal Litman
Center For Advanced Technology
Food manufacturing Technology Facility
120 New England Avenue
Piscataway, New Jersey 08854

Dear Neal:

Good Morning!

Thank you for the opportunity to assist with your search for an appropriate lid structure for your military food tray. As we previously discussed, I believe we have a structure that will:

- offer suitable corrosion resistance;
- provide adequate burst strength,
- withstand the rigors of your retort process,
- be non-peelable, and
- provide excellent tensile strength and tear resistance.

This structure is identified as LF(N)135 and consists of: 1.3 mil foil/48 gauge polyester/heat seal coating. It fully complies with all appropriate FDA regulations.

Two different heat seal coatings for sealing to polyester can be applied as follows:

Designation	Characteristics
N	PET lacquer system, suitable for retort, very aggressive
Y4	Vinyl modified PET lacquer system, suitable for retort (higher heat resistant), aggressive

I recommend that initially you test a sample roll of LF(N)135N. Lead time is three to four weeks. The prices for these structures are:

LF(N)135N	**$194.45/M Impressions**
~~**LF(N)135Y4**~~	~~**$271.59/M Impressions**~~

The above prices are based upon the following criteria:

Estimated Annual Usage:	**4MM (2MM the first year)**
Order Size:	**500M**
Width:	**11 7/8"**
Repeat:	**14"**
Impressions:	**166.25 sq. in.**
Print:	**Not Applicable**
Freight:	**Paid to New Jersey**
Terms:	**Net 30 Days**
Lead Time:	**Six weeks from date of order entry to date of shipment.**

Hopefully the above costs are within your budgetary constraints.

Again, thank you for your attention. I will be in touch with you shortly.

Sincerely,

Bailey

F. Bailey Anderson

FBA/sna

cc: Mr. Louis de Bellefeuille, Heat Seal Packaging

RIGID POLYMERIC CONTAINER PROCESSING

STP 10

PROCESS ACTION TEAM (PAT) MEETING MARCH 12-13, 1996

DUAL USE- COMMERCIAL PRODUCT

* CPET - 40 MIL
* RUTGERS HAS ORDER FOR 600 TRAYS/WEEK
* LARGE SUPERMARKET CHAIN (150 STORES)
* PRODUCT IS 6# OF MACARONI & CHEESE
* PRODUCT SOLD IN DELI DEPARTMENT
* COST $.47/TRAY
* OTHER FUTURE PRODUCT - 3# TRAY

RAQUE HEAT SEAL MACHINE CHANGE PARTS
(1/4 STEAM TABLE TRAY)

* TRAY CARRIERS	19,000
* SEALING PLATENS	4,800
* DIE CUT HEAD ASSEMBLY	6,500
* LIFTER PADS	1,500
TOTAL	$31,800

MULLINIX HALF STEAM TABLE TRAY

* CPET - 60 MIL
* FLANGE MODIFIED FOR IMPROVED SEALING
* DUAL OVENABLE
* RETORTABLE
* COST $.67/TRAY

TRAY LID MATERIAL

* MILITARY - FOIL LAMINATE - COST $.26/TRAY

* CIVILIAN - NYLON - COST $.12/TRAY